The Billfish Story

SWORDFISH, SAILFISH, MARLIN, AND OTHER GLADIATORS OF THE SEA

STAN ULANSKI

VISIT…

The Billfish Story

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AVALON
CATALINA ISLAND

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SAILFISH, MARLIN,
AND OTHER
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Stan Ulanski

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Acknowledgments

Almost twenty-five years ago, I caught my first billfish, a blue marlin, in the Gulf Stream waters off North Carolina. By marlin standards it was not a huge fish, probably topping out at approximately three hundred pounds, but its tenacity, power, and jumping ability made a lasting impression on me—leading me on a path of discovery and angling adventures that I continue to pursue.

I am particularly grateful to Laura Sutton, former acquisitions editor at the University of Georgia Press, who from the start allowed me to express my passion about billfish through her support of this book. As time has gone by, Regan Huff, also of the University of Georgia Press, has continued to efficiently guide the project through the maze of reviews and revisions.

Any discussion of billfish should be rich with images. All billfish paintings here are by Duane Raver, who is most generous in sharing his detailed illustrations of marine life. I was fortunate to make the acquaintance of Tom McMurray, who graciously allowed me to use many of his dynamic white marlin and billfish tournament photographs. I hope you enjoy them as much as I have. Rebecca Bunker used her drawing prowess to craft the figures, which add depth to the book.

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leaders, with Ellen Peel of the Billfish Foundation leading the way; mates; and researchers whose enthusiasm for these magnificent creatures is infectious.

The Billfish Story

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Introduction

Roaming the blue waters of the Atlantic Ocean are predators at the apex of the oceanic food chain—the billfish. These species include the sailfish, spearfish, white and blue marlin, which are all part of the same biological family, Istiophoridae; and the swordfish, the only member of the Xiphidae family. Probably no other feature better defines these fish than their long, pointed bills, which have been used by swordfish to pierce the hulls of unsuspecting ships and by sailfish to slash through schools of panicked baitfish.

Noted for their speed, size, and acrobatic jumps, billfish have inspired a broad spectrum of society for decades, from scientists to writers to big-game anglers. As far back as antiquity, Aristotle observed swordfish that annually migrated into the Mediterranean Sea, naming them *xiphias* (the sword). Bernard Lacépède, a French naturalist, systematically studied the blue marlin as early as 1802. Zane Grey, known mainly for extensive chronicles of the American Old West, detailed the use of light fishing tackle to catch sailfish off the Florida Keys in *Fishing in the Gulf Stream* (1922). And Ernest Hemingway drew on his numerous fishing adventures to craft his acclaimed novel *The Old Man and the Sea* (1952)—an epic tale of an old Cuban, Santiago, battling with a marlin and with his obsession with proving himself a worthy slayer of such a grand beast. Present-day anglers can definitely associate with Santiago's compulsiveness as they passionately pursue the elusive billfish. With the advent of big-game fishing at the end of the nineteenth century off of Catalina Island in California, numerous tournaments along the eastern seaboard now attract hundreds of anglers. The annual Ocean City

White Marlin Tournament, for example, pits the best anglers along the mid-Atlantic coast against one another in an adrenaline-fueled, high-stakes, and high-dollar competition.

As the subtitle tells you, this book relates a story of a unique group of marine organisms, the billfish, and the people who have formed bonds with them—anglers, biologists, charter-boat captains, and marine officials—from their study, pursuit, and conservation efforts of these fish. (While two other billfish, striped and black marlin, are found in Indo-Pacific waters, my focus lies primarily on Atlantic billfish.)

My main goal is to meld part natural history of billfish, part angling adventure, and part cultural examination into a straightforward primer to Atlantic billfish. This holistic approach to the subject is intended to lead you, the reader, on a journey of discovery, an odyssey during which the billfish becomes a blank slate upon which to project discussions of angling traditions, limits of scientific research, and economic relevance.

As I hope this book makes clear, the anatomy and physiology of these fish are both unique and complex, allowing them to survive and hunt in their vast watery environment. Blue marlin, the largest of all the billfish, reaching weights of over one thousand pounds, migrate long distances, powered by a combination of oxygen-fueled muscles and a sickle-shaped tail fin. The large, bulbous eyes of the nocturnal-feeding swordfish allow it to detect prey even in the dim reaches of the abyss. Able to elevate its brain temperature ten degrees above the ambient water temperature, the swordfish can probe depths beyond the reach of other billfish. Vertical bars of pale blue spots along the flanks of a sailfish, one of the swiftest fish in the ocean, flash iridescence as it pursues a school of fleeing sardines.

Over the years, researchers have developed a bewildering array of sophisticated instrumentation to systematically study billfish. Spatial and temporal movements of these pelagic wanderers are starting to reveal themselves through the use of electronic "tags," which are attached externally to the fish, release ("pop up") at a programmed time, float to the surface, and begin the transmission of data (swimming depth, water temperature, body temperature, and ambient light) to a satellite.

Genetic analysis of tissue samples from billfish has led to revision of the billfish family tree, adding new species, such as the roundscale spearfish, and reclassifying species, such as the white marlin. The release of the genetic genie has been a boon to resource managers and conservation organizations, aiding in their efforts to prevent overexploitation of threatened species and maintain a robust population of billfish.

Not to be outdone by their scientific counterparts, big-game anglers have risen to the challenge of incorporating technology in their pursuit of billfish, constantly tweaking their angling methods and gear to outsmart and outguess their wily adversary. Some anglers have gone as far as developing a cottage industry around the premise that billfish are attracted to particular sounds that are produced by trolled lures, which replicate distressed baitfish sound frequencies. But in many ways billfish still remain a mystery to scientists and anglers alike, posing more questions than answers. Is the bill a vestige from prehistoric times when the seas teemed with armed predatory fish? Why does a hard-charging blue marlin miss the bait or lure in spite of the visual and/or auditory signals from this target? Billfish, as a group, may be reluctant to reveal all their secrets.

Billfish are under attack, their existence threatened by overfishing and a shrinking habitat. Current landings of a number of billfish species are well above the replacement yield. The majority of the billfish harvest is driven by the industrial longline and purse seine fisheries for tuna, with billfish caught as a by-product of the tuna production process. Recently researchers have shown that an expanded area of low oxygen, known as a hypoxic zone, in the eastern Atlantic Ocean is encroaching on these species' preferred oxygen-enriched habitat. The problem is exacerbated by the growing concern about climatic change and its impact on the marine environment. The billfish's association with man has historically been an uneasy one. Early Greek chroniclers reported the relentless hunting of swordfish in the Strait of Messina off the coast of Italy over two thousand years ago, and still today the billfish is fraught with many troubling encounters.

While this book is a story of the most important billfish discoveries, it also shows that billfish occupy, and have for centuries, a unique

importance in human culture and society. The billfish stands as more than a discrete object to be probed and measured, caught and discarded; rather, it serves as the nexus of a story that links natural history and human history.

1 The Rise of Billfish

An eighty-pound female sailfish, large for her species, slowly cruises the cobalt-blue waters around the island of Bermuda in search of her next meal. She has ridden the powerful Gulf Stream to this ancient island, which plunges thousands of feet to the ocean floor. As the result of a complex interplay of Bermuda's underwater topography and current flow, nutrient-enriched water has welled up from the depths to initiate a food chain. As if out of nowhere, microscopic plants and animals appear—a meadow of life spreads across the ocean surface—and baitfish move in to partake of this cornucopia of organisms. But the sailfish is also ready to assume her role as the apex predator. Using her large eyes, she searches the dim reaches of the water column for her prey, looking for any tell-tale sign of life. Subtle movements below catch her attention, and she is now on full alert. The school of herring also senses her presence and assumes a defensive posture, instinctively congregating into a bait ball—a whirling mass of panic-stricken fish, a living tornado counting on safety in numbers.

The sailfish slowly circles the bait ball, herding her prey into an ever-tightening circle. Usually the denser the clustering of prey, the safer are the individuals in it, since most predators have difficulty singling out an individual, isolating it from its neighbors. But by all accounts, the sailfish is a finely attuned predator, who will turn this defensive posture against the prey.

She is adorned for the battle. Like the hoisting of the Jolly Roger banner, she has raised her saillike dorsal fin to its maximum vertical extent, giving the impression of a much larger organism. Her body

PHOTO 1. Sailfish and bait ball. Copyright Istockphoto.com / Amanda Cotton.

flashes with color, often in silvery blue stripes. The color bursts serve to further unsettle the skittish prey. But this outward display of prowess is short-lived; it is time for her to feed. She retracts her pelvic fins into a pair of grooves along the ventral side of her body. Propelled by her powerful, sickle-shaped tail, she darts into the outer "wall" of the bait ball, her now streamlined form allowing her to reach eye-blurring speeds. The bait ball starts to break down as individual members scatter, seeking to avoid the oncoming attack. But to no avail. With each sharp turn she makes in the bait ball, her swordlike bill hits and stuns numerous prey. She then turns and consumes her victims headfirst, feeding until she is satiated. All that remains from this onslaught are

the silvery scales of the herring slowly sinking into the depths. This primal act has been played out over the centuries in a watery arena, tens of millions of years old, which she shares with other billfish: white marlin and blue marlin, spearfish and swordfish.

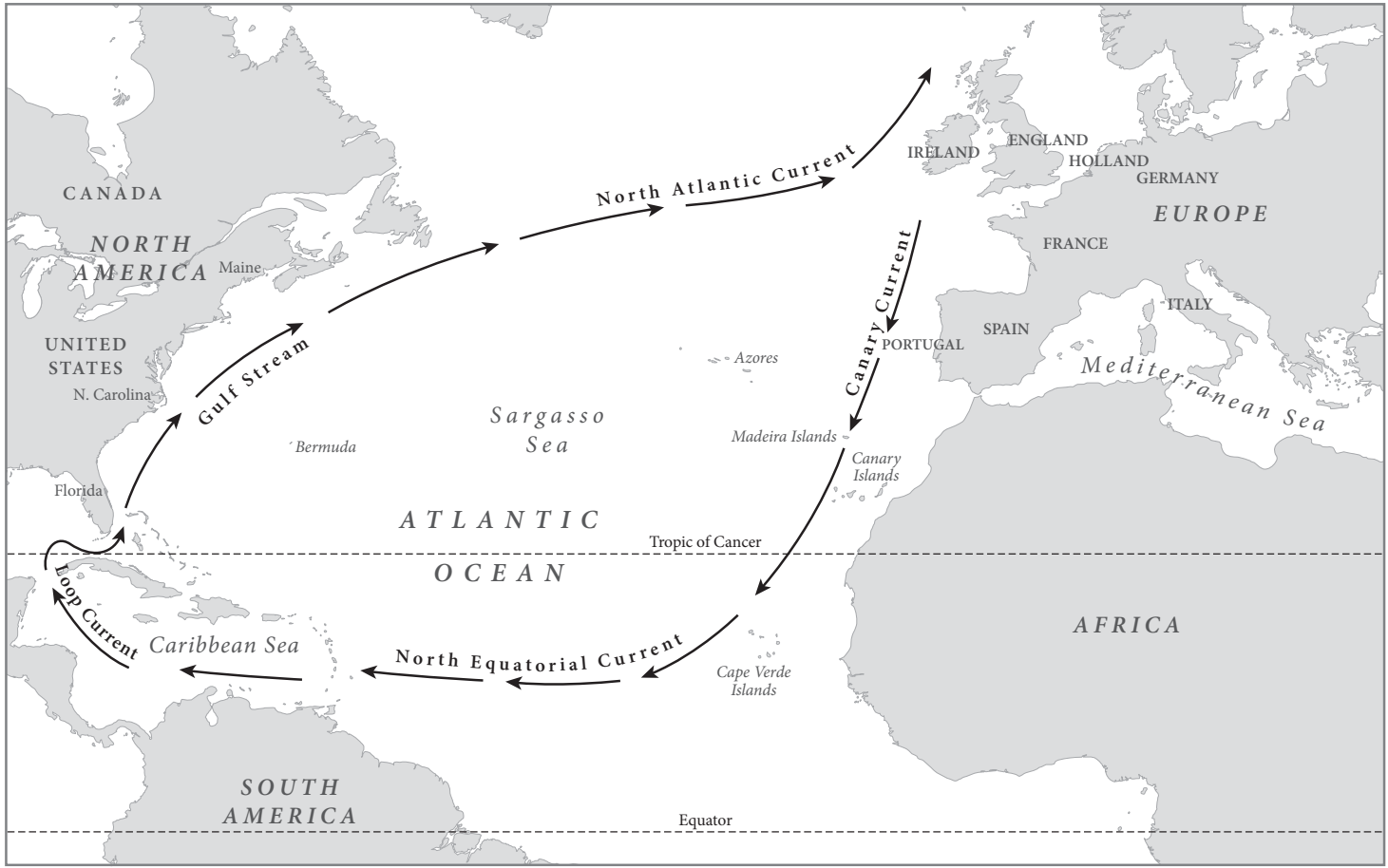
Stirrings within an Old Earth

The evolution of these gladiators of the sea over the eons is inextricably linked to shifting continents, the opening of new seaways, and the birth of new land forms, changes that have provided the impetus for the rise of new life forms and the demise of long-established ones. This evolutionary story is an old tale—one much older than any billfish.

Through the accumulation and analysis of interlocking lines of evidence, geologists tell us with considerable confidence that the earth is 4.6 billion years old. Yet the geography of the planet only 200 million years ago was markedly different than it is today. Landmasses were locked together in the supercontinent Pangaea and surrounded by the vast ocean Panthalassa.

The breakup of Pangaea, which came to be known as continental drift, did not occur uniformly over time; most of the continents broke away sporadically. The earliest new ocean was the southern North Atlantic, an embryonic seaway formed about 165 million years ago. By the late Cretaceous Period, 94 million years ago, the breakup of Pangaea was complete, but it was not until another 60 million years passed that the Atlantic Ocean took on a shape and appearance that would be recognizable today, stretching unimpeded from almost pole to pole—a new niche for the life to come.

Though continental drift is powered by immense plumes of molten material that rise from great depths within the earth, visible manifestations of a restless planet are volcanic eruptions deep in the oceans. For example, on the morning of November 14, 1963, an underwater volcano erupted violently off the coast of Iceland, sending an ash plume thirty thousand feet into the sky, clearly visible to the residents of Reykjavik. By the evening of November 15, the island of Surtsey had emerged from the waters of North Atlantic, and the planet's newest volcanic island had been born. Lava eruptions continued throughout



MAP 1. Ocean Currents in the North Atlantic

much of 1964, building the island to an elevation of more than five hundred feet above sea level.

While Surtsey is very young, geologically speaking, Bermuda is much older—approximately 100 million years old. In spite of the age differences, they share a common background. Both are volcanic islands that formed when new crustal material gushed from the inner bowels of the planet. Long extinct for tens of millions of years, Bermuda has undergone a marked change in appearance, developing a limestone cap on top of the ancient volcanic rock. The origin of this calcium carbonate topping is living organisms—reef builders, which include coral and the algae that live symbiotically with them. The result of this biological construction was an influx of organisms, both small and large, that have populated the reefs and the surrounding waters. Similar landforms, such as the Azores and Cape Verde Islands, can be found in the eastern Atlantic. Born of the same dynamic processes that led to the origin of Surtsey, the waters of these volcanic islands are magnets for other billfish, such as blue marlin, which, like Bermuda sailfish, travel long distances to seek prey in these fertile waters.

With these changes in the appearance of the northern and southern Atlantic came a new vitality, as if the ocean were developing a pulse. Large swirls of water, or gyres, became a prominent and permanent feature, stirred into motion by globe-girdling winds. These vast gyres, enclosing over a million square miles of ocean, have coursed through the Atlantic for millions of years, transporting not only water and heat but also life, from tiny, drifting organisms to early human explorers.

An integral part of the North Atlantic gyre is the Gulf Stream, which has existed for over 30 million years. Clearly visible from space, this prodigious current flows northward along the east coast of North America toward Newfoundland at speeds over five knots, a fact that sixteenth-century Europeans would experience firsthand. According to historian Robert Fuson, the Spaniard Ponce de León, while exploring the Florida coast in 1513, noted in his log that a large brigantine, which attempted to anchor in the Gulf Stream, was soon "carried away by the current and lost from sight although it was a clear day."

Transporting over a billion gallons of water per second, an amount hundreds of times that of the combined flows of the mighty Amazon

and Mississippi rivers, the Gulf Stream is an oceanic river like no river on land. Its "banks" are fluid ocean, not soil and rock, and as if alive, the current twists and turns in great sweeping loops, shedding off swirling vortices one hundred to two hundred miles in diameter.

Due to the Gulf Stream's origin deep within the tropics, its sea surface temperatures are generally above 80°F, fifteen degrees higher than in the surrounding waters. As early as 1606, the French historian Marc Lescarbot recognized that the key element in locating the position of the Gulf Stream was the warmth of its water. While aboard the ship *Jonas*, Lescarbot recorded that "six times twenty leagues to the Banks of Newfoundland, we found for the space of three days the water very warm, whilst the air was cold as before." More than four hundred years later, savvy anglers still rely on temperature to pinpoint sites within the current that are preferred by game fish. This warm, swift current is only one link in the great North Atlantic gyre, which would become the sea highway for the migration of billfish throughout the Atlantic, from their spawning grounds to their feeding haunts.

Life Emerges in the Earth's Seas

The Atlantic Ocean, born from massive geologic upheavals, dotted with volcanic islands that slowly and persistently move on great slabs of the earth, and alive with large circular flows, is today home to sailfish and spearfish, to white marlin and blue marlin, and to swordfish. But the fish that roamed the very ancient seas were markedly different from their modern counterparts. These first fish, the ostracoderms, appeared about 500 million years ago, well before the breakup of Pangaea. These jawless fish were slow, bottom-dwelling organisms that were covered from head to tail with heavy armor of thick bony plates and scales. This thick plating may have been the result of an evolutionary arms race with their nemesis—the giant sea scorpion. Recently, Simon Braddy of the University of Bristol in England and his colleagues reported finding an eighteen-inch fossilized sea scorpion claw, from which they infer that its length approached almost eight feet. The ostracoderms may have evolved an armored body as a means of protection from these very strong claws, which could crack open most any rigid outer covering.

The next 150 million years, extending into the Devonian Period (410 to 359 million years ago), was a time of great evolutionary diversification in fish. Probably the most successful in this Age of Fishes were the armored placoderms, which ruled the seas, lakes, and rivers for nearly 60 million years. These fish were among the first jawed fish, and while many were small and medium-sized, a true giant, *Dunkleosteus*, appeared in the late Devonian, attaining a length of over thirty feet and a weight of four tons. This ferocious predator, armed with two pairs of sharp, bladelike plates that acted as teeth, developed into a fish-slicing monster.

As the Devonian was drawing to a close, a cataclysmic mass extinction occurred, which impacted the marine community the most. As successful as the fish families had been during this period, just as mysteriously did they disappear from the planet, more than 120 million years before the dawn of the first dinosaurs.

But this catastrophic global event hit the reset button on earth's life, setting the stage for the arrival of modern-day vertebrates. While the Devonian extinction almost wiped the slate clean, a few hardy species survived and became the evolutionary starting point for a new cast of players. Between the late Devonian Period and the subsequent Carboniferous Period (355 to 290 million years ago), ray-finned fish replaced the placoderms and other primitive fish as the dominant group. During the Carboniferous and Permian periods (290 to 250 million years ago), ray-fins underwent a burst of diversification into more than forty new families.

At the end of the Permian, the earth would be rocked by the greatest mass extinction during the last 600 million years, during which 90 percent of the marine animal species vanished. Those that survived included primitive bony fish and sharks, but with the number of their species greatly diminished. These survivors, particularly the bony fish, entered into another period of stability, during which species diversity increased as the remaining tolerant species began an evolutionary adaptation to their new environment—leading to the entrance of the teleosts.

The great majority of modern fish are teleosts, of which there are about thirty thousand species (about equal to all other vertebrate

groups combined). Teleosts are ray-finned fish with bony skeletons, as distinct from cartilaginous fish, such as sharks, rays, and skates. But a key feature defining this group is the presence of specialized bones in the tail section, which function to stiffen the upper lobe of the tail. This simple anatomical feature endowed the teleosts with greater swimming speeds, which we see in all billfish, and facilitated a great variety of body shapes to evolve, including the billfish's hydrodynamically streamlined form.

The earliest teleosts appeared in the Middle Triassic, some 230 million years ago. By this time they had evolved into efficient swimmers, having shed the heavy armor of their ancestors and developing greatly improved tail skeletons. Also, as a result of modifications to their jaws, which yielded a greater range of motion, the teleosts became more proficient at catching and grasping prey. During the Jurassic Period (205 to 135 million years ago), when the supercontinent Pangaea was breaking up and new seaways were opening, teleosts experienced their greatest diversification as they occupied and flourished in new bodies of water. By the middle of the Cretaceous Period, 100 million years ago, teleosts were established throughout the earth's marine environment.

Billfish: New Species Come on the Scene

But an important question remains: when did billfish first make their appearance in the geologic record? From the ostracoderm to the placoderm to the early teleost, each of these organisms was part of an evolutionary timeline, well suited for their time on earth. Would billfish be next in line, the product of the next evolutionary hiccup? Billfish, as a group, have unique morphological and physiological characteristics that allow them to swim almost nonstop, attain eye-blurring speeds, develop unique feeding strategies, and range throughout the temperate and tropical waters of the Atlantic. Even to the most casual observer of marine life, billfish are readily recognized by their long, spearlike beaks, hence their collective name. The blue marlin's genus name *Makaira* is derived from the Latin *machaera*, which means "sword," and the swordfish's snout elongates into a true sword shape. Measuring at least one-third the length of its body, it is long, wide, and very sharp.

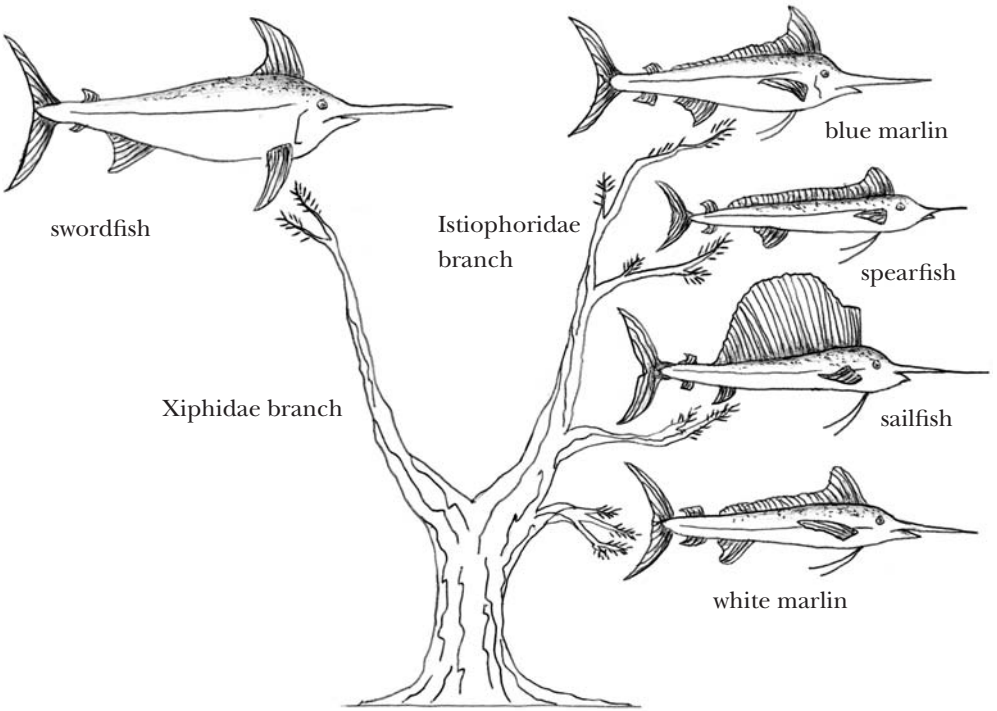


FIG. 1. Billfish family tree. Courtesy of Rebecca Bunker.

The famous taxonomist Carl Linnaeus first described the swordfish in 1758, providing the name still in use today, *Xiphias gladius*.

While prehistoric fish extinction at the end of the Cretaceous Period (65 million years ago) may have paved the way for modern marine vertebrates, a very long period of time was needed to develop the highly specialized billfish of today. A perfect storm of suitable habitat, morphological adaptations to cope with the new environment, and lack of predators would all have to come together to spur the rise of billfish throughout geologic history.

Victorian-era paleontologists were ecstatic to find in 1822 the fossilized remains of very large pectoral spines that they ultimately concluded

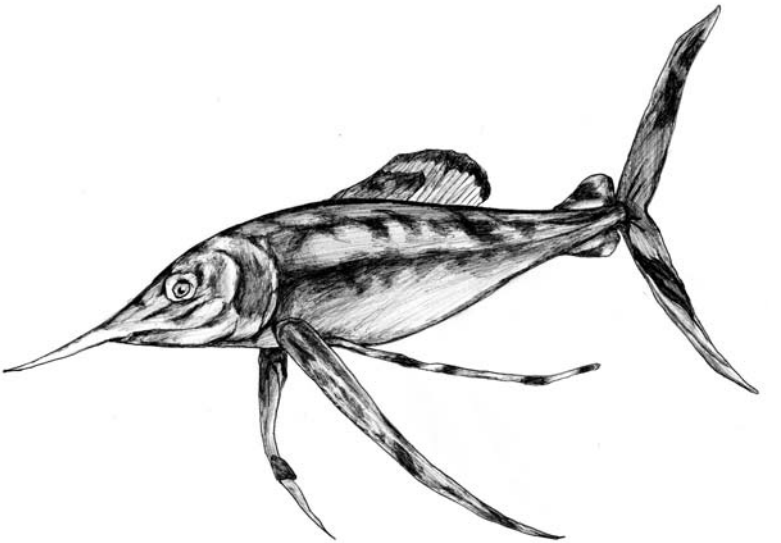


FIG. 2. *Protosphyraena perniciosa.* Courtesy of Rebecca Bunker.

belonged to a fierce predator, *Protosphyraena perniciosa*, which roamed the seas during the Upper Cretaceous Period (about 100 to 66 million years ago). What intrigued the researchers was that the reconstructed body of *Protosphyraena* resembled that of a modern day swordfish, albeit with a shorter beak and long, serrated pelvic fins. In spite of these differences, the scientific community steadfastly continued to view *Protosphyraena perniciosa* as the ancestor to today's swordfish. But a major glitch in their belief was that this ancient fish possessed a mouthful of large, daggerlike teeth, which it most assuredly used to grasp and slice its prey; yet adult swordfish are toothless and swallow their prey whole. Recent research has shown that the genus *Protosphyraena* is not at all related to the swordfish family, Xiphidae, but belongs to the long-extinct family Pachycormidae. But even this wrong turn would only fuel the desire of fossil hunters to find the remains of billfish—the quest would only grow.

Harry Fierstine, the foremost expert on the fossil history of billfish, has shown that there were three early families of billfish that are now extinct: Blochiidae, Hemingwayidae, and Palaeorhynchidae. The earliest of

these families, Hemingwayidae (named after Ernest Hemingway), dates back more than 55 million years ago, a time of a smaller Atlantic than now. Based on fossil evidence, he concluded that these ancestral billfish did not swim actively or probe the depths, counter to the habits of some modern-day billfish. Even more revealing is that their upper and lower jaws were of equal length, which probably limited their ability to use the bill as a feeding tool. But by about 5 million years later, the Blochiidae family had developed a rostrum or bill where the upper jaw was considerably longer than the lower. This adaptation, as Fierstine points out, would allow the billfish to engulf its prey by swimming over it.

Even today, in spite of technological advances, our paleontological knowledge is scarce and fragmented. Fossil specimens of sailfish, longbill spearfish, and white marlin have been difficult to come by, and those that are found are often a single, fragmentary vertebra. The paleontological evidence for blue marlin and swordfish is a bit better, with the best specimen for the former probably being a nearly complete fossil skull, including the bill, and for the latter an almost full length, albeit small (four feet), fossil. From these rare finds and from piecing together other bits of geologic information, paleontologists have determined that the geological record of billfish is relatively short, dating back only to the middle Miocene (15 million years ago) for blue marlin, sailfish, and swordfish, and only 5 million years for some white marlin and longbill spearfish specimens.

Telling a Book by Its Cover?

One particular offshoot of the evolutionary tree of fish is the scombroids—a collection of primarily predatory fish that includes mackerels, bonitos, tunas, and billfishes. These each possess many of the same morphological and physiological characteristics, which allow them to flourish in their pelagic environment. In particular, tuna and some billfish are able to elevate the temperature of parts of their body relative to their surroundings, allowing them to expand their geographical range. So some researchers have argued, based on similar traits, that tuna and billfish are close cousins, in the biological sense, having shared a close evolutionary history. But the phylogenetic relationship

between scombroids remains murky, and numerous studies have come to conflicting conclusions, until recently.

Alex Little and his team from Queen's University in Canada used DNA sequencing of muscle samples collected from tuna and billfish to resolve this sticky issue of classification. Methodically, they compared their results with sequences from additional fish species that are obtainable from GenBank, which makes publically available DNA sequencing. The team was startled to find that billfish and tuna are only distantly related in spite of their similarities.

But are there any close relatives to billfish, or do they stand alone as a unique and distinct group? Little's group was also surprised to find that billfish are closely related to flatfish, such as flounder, halibut, and plaice. But how could that be? Were their results in error? Even a cursory look at a flatfish shows morphology distinctively different than that of a billfish: a compressed body, both eyes located on the same side of its head, and a large, broomlike tail. If you don't focus on the distinctive outward features—long bills and bizarre eyes—and look internally, the result is the skeletons of billfish and flatfish share features that are not present in tuna.

This led Little's group to conclude as well that shared natural selection pressures can lead to similar adaptations in species that are only remotely related, or that these adaptations developed independently in these two fish populations. For example, even closely related species, like white marlin and flounder, can end up looking markedly different if they adapt to diverse lifestyles: sedentary versus athletic. The flounder, for example, is an ambush predator, content to remain concealed in the bottom sediments until an unsuspecting prey swims by, at which point the flounder finally stirs into action. In contrast, distantly related species, such as tuna and swordfish, can end up having similar features, streamlined bodies, large, lunate-shaped tails, because they have adapted to similar challenges—hunting and capturing fast, elusive prey—a testament to the power of natural selection.

Exposing Billfish Secrets

The highly skilled forensic technicians who are depicted almost daily on television as the ultimate crime scene investigators have nothing on today's fishery geneticists, who work tirelessly to unravel the mysteries of billfish. And perhaps none is more prominent than John Graves, professor of marine science at the Virginia Institute of Marine Science, College of William and Mary. A man comfortable within both the professional and public arenas of fishery science, Graves has devoted much of his career to the genetic analysis of billfish. While he concedes that the primary objective of his research is the application of modern molecular techniques to define the population structure of billfish, his work has implications for the cohesive management of billfish from both national and international perspectives.

As Graves expanded the bounds of genetic testing on billfish, an intriguing question came to the forefront: were there significant genetic differences in particular billfish species that inhabit the Atlantic Ocean? As opposed to freshwater organisms that are generally confined to a specific environment, such as a lake or isolated upper reaches of a river, pelagic organisms inhabit an environment that is basically devoid of any barriers to isolate different populations. Graves argued that because of the highly migratory nature of billfish and an essentially boundless habitat, mixing should occur between widely separated populations and thus genetic differences would be at a minimum. To test his hypothesis, Graves and his team collected fifty-seven blue marlin samples from four geographic regions: western North Atlantic, the Caribbean Sea, western South Atlantic, and the eastern Atlantic.

The genetic analysis conclusively showed that there was little spatial heterogeneity among the blue marlin samples due to possible gene flow. In other words, a blue marlin caught in Georgia is not genetically different from a blue marlin roaming the waters off of Brazil.

But what if we were to look at the Atlantic and Pacific blue marlin, which have long been isolated since the formation of the Isthmus of Panama approximately 3 million years ago due to the convergence of shifting portions of the earth's crust? Are they, as many investigators

believe, distinct species, having evolved along different paths? For decades, taxonomists have classified both marlin under the genus *Makaira* but applied the species names *nigricans* and *mazara* to the Atlantic and Pacific marlin, respectively. Granted they look the same, but could our dynamic earth have led to different speciation within the blue marlin group?

Again, Graves and his colleagues were able to demonstrate that individual Atlantic and Pacific blue marlin share the same genetic "fingerprint" or genotype, proving that they indeed are closely related and are the same species. In this case, you can tell the book by its cover. This finding, while expanding our knowledge of billfish biology, may have an impact beyond the scientific world. At present, the big-game angling community recognizes two separate all-tackle records for the blue marlin: one for the Atlantic blue marlin (1,402 pounds) and the other for the Pacific blue marlin (1,376 pounds). Could a revision be in order?

The lack of distinct speciation between the Atlantic and Pacific blue marlin may be attributed to the previous existence of the Central Atlantic Seaway—a wide swath of water that covered present-day Panama and much of Central America since the Mesozoic. For millions of years, this opening facilitated a vigorous exchange of water between the Atlantic and Pacific and may have been the conduit for the movement of blue marlin between the oceans, promoting their mixing.

A spinoff of Graves's research was to compare the marlin results with those from other widely distributed and isolated nonbillfish species, such as bluefish and mackerel. Surprisingly, the results showed greater genetic divergence among the populations of bluefish and mackerel than for the billfish samples. Bluefish, for example, inhabit the coastal waters of the Americas, Europe, and Africa. Though it is well known that this species undergoes a seasonal migration along the eastern United States seaboard, there is no evidence of any transatlantic movement and mingling with their eastern Atlantic counterparts.

The molecular technology genie that Graves and others have released has created a firestorm of activity in the hunt for new species. Almost daily, it appears that researchers are finding previously undocumented species, many of which are microscopic to tiny, and many of which inhabit hostile environments, like deep underground or within

the ocean's abyss. Until recently, the existence of new pelagic species has proved elusive to confirm.

Approximately a decade ago, George Hinteregger, while a National Marine Fisheries Service observer on a commercial fishing vessel, came upon what on first glance appeared to be a common Atlantic white marlin, which had been hauled onboard. But upon closer examination, Hinteregger was convinced that something was askew; this "white marlin" looked slightly different than others he had seen. But further analysis would have to wait until the fish was brought back to the lab. A colleague intrigued by Hinteregger's specimen recalled a 1974 paper by C. R. Robins, which purported to describe a new billfish—the roundscale spearfish. Robins's findings, however, were based on assessment of only four specimens (one of which was damaged, preventing robust morphological analysis), thus the validity and distribution of this species was questioned.

The roundscale spearfish derives its name from its scales, which are soft, pliable, and round. In contrast, the scales of a white marlin are thin, sturdy, and flat. While there were indeed distinct morphological differences, though not readily visible to the casual observer, this evidence was not sufficient to formally declare the roundscale spearfish a new species. Additional proof was needed by the skeptical scientific community at large; otherwise the roundscale's very existence would fall into the realm of other dubious characters: the abominable snowman and sasquatch.

Enter into the picture Mahmood Shivji, a geneticist at Nova Southeastern University in Florida. Comparing the DNA from other roundscale billfish that had been collected over a ten-year period with that from white marlin, longbill spearfish, striped marlin, and Mediterranean spearfish, Shivji summarized his findings in an interview with Janet Raloff for *Science News*: the roundscale spearfish belongs to "a distinct evolutionary group unto itself." It was indeed a new species, which may have ancestral linkage to marlins, but only in the distant past.

Hinteregger's and Shivji's research, though answering one question about billfish, has led to a follow-up question: how abundant is the roundscale spearfish, given that only twenty specimens have been identified over the last twenty years? One possible answer is that since

the roundscale spearfish is a dead ringer for white marlin, many that are caught are simply misidentified. Or is, in fact, the population of roundscale spearfish low compared to other billfish? Many possibilities abound, including competition for resources, low birth rates, and environmental stresses. The evolutionary part of the billfish story is still incomplete, but new research continues to shed light on these unique fish, with new chapters still to be written.

2

The Interlocking Web of Ocean Life

FROM PLANKTON TO BILLFISH

During the last week of September 1492, Christopher Columbus had more to worry about than finding a sea passage to the Orient; his ships were adrift in the center of the Atlantic Ocean, becalmed by weak winds and lack of currents. Columbus immediately recognized the gravity of the situation. With the possibility of running out of potable water, Columbus and all aboard faced the ominous prospect of dying from thirst. But his crew, a superstitious lot to begin with, harbored a greater fear: that the maze of seaweedlike plants, which washed against their vessel, would become so thick and tangled as to irretrievably ensnare their ship. They whispered among themselves that a weed-shrouded sailing ship would have little chance of exiting this stagnant sea, condemning them to a fate of drifting forever in an endless expanse of ocean.

To Columbus, the seaweed was more of a hopeful omen than a threat, because he viewed it as a sign that he was close to land. Most of his experiences with seaweeds were with near-shore species that were anchored to the bottom. With the hope that land was nearby, he ordered his crew to sound the sea, only to find, to his dismay, a great abyss. Columbus's men grew even more despondent, convinced that they would never see their homeland again. Murmurs of mutiny spread around the ships. But after two agonizing days, a freshening breeze billowed the ships' sails and lifted the spirits of the men. They had drifted back into the realm of the trade winds. The westward trek to the Orient continued.

A Marine Jungle

The so-called nemesis plant that had spooked Columbus's crew is the sargassum weed (actually a brown algae) that is composed of two species, *Sargassum natans* and *Sargassum fluitans*. This floating plant is the signature drifter of the North Atlantic gyre and gives the center of the Atlantic, known as the Sargasso Sea, its name. The Sargasso Sea is fixed in nautical lore. Detailing the adventures of Captain Nemo in *Twenty Thousand Leagues under the Sea* (1870), Jules Verne vividly describes the perils of this vast patch of calm water where sargassum weed gathers in huge mats. "Such was the region the Nautilus was now visiting, a perfect meadow, a close carpet of seaweed, fucus, and tropical berries, so thick and so compact that the stern of the vessel could hardly tear its way through it." While the sargassum is neither thick nor strong enough to stop a ship, this old myth persisted well into the nineteenth century. The tabloid press promoted the idea that freighters sat becalmed and weed encrusted along with sailing ships from Roman times.

Hemmed in by the encircling gyre, little of the sargassum ever exits its languid home. There are millions of tons of this plant adrift in the "eye" of the North Atlantic gyre. Of the sargassum that does leave the Sargasso Sea, winds, storms, and currents disperse it throughout the Gulf of Mexico, the Caribbean, and the western Atlantic. But some of the material hitches a ride on the Gulf Stream and travels up the Atlantic coast. Upon being incorporated into the Gulf Stream, the sargassum aggregates into long, thin rows, or flotsam lines. These linear patches form in response to the wind forcing or shearing currents, known as rips, along the boundary of the Gulf Stream. Rips are characterized by long, narrow bands of calm water and are bracketed on either side by rough water. The floating sargassum will often collect in the calm areas of the rip. On its journey northward, some of the sargassum is ultimately entrained into the whirling vortices of the Gulf Stream, bringing it either closer to shore or back to the Sargasso Sea. But sargassum does not live or drift forever. As clumps of the seaweed become encrusted over time, its natural buoyancy is overcome by increased weight, leaving only a slow descent to the cold, perpetually dark bottom of the North Atlantic.

PHOTO 2. Sargassum weed. Copyright Shutterstock.com / Allen Stoddard.

Sargassum was originally christened *salgazo* by the early Portuguese sailors because the plant's tiny floats reminded them of a small grape found in their homeland. But if these mariners had only peered closer at this maze of plants, they would have been startled by the abundance of life found in and on this vegetation.

Pioneering ocean-going biologists soon recognized the importance of this unique plant: Gulf Stream sargassum supported a diverse group of marine organisms. Nestled within the tangled maze of stems, fronds, and floats are fungi, micro- and macro-epiphytes (plants that grow on other plants), and dozens upon dozens of invertebrates and small fish. This web of life comprises a "floating jungle." Scientists as well as knowledgeable anglers have proposed that the high diversity of organisms dependent on this marine jungle may be the result of myriad factors: protection, shade, feeding opportunity, and spawning substrate. But whatever the reason, wherever there is a concentration of prey, hungry predators make their presence known. This hunter and hunted relationship is probably best summarized by this simple maxim: critters go where there is food.

Dolphin (or dolphinfish—not to be confused with the marine mammal), colorful, pelagic game fish, have a particular affinity to sargassum

weed. Attracted to the smorgasbord of marine organisms that inhabit the sargassum, dozens of dolphin in the five- to ten-pound range may be found holding just below even the smallest clumps of sargassum—an oasis in the relatively barren sea. But roaming these same waters is the granddaddy of all billfish—the blue marlin. Its prodigious size (reaching weights of over one thousand pounds) necessitates the consumption of copious amounts of prey. As top-level predators, marlin are inextricably linked to even the lowest organisms on the marine food chain. But because of loss or use of energy along each step of the food chain, only a small percentage—10 percent—of the food consumed is converted to weight. (A thousand-pound marlin must have consumed a whopping ten thousand pounds of prey over its lifetime.) While the above argument is relatively simplistic in nature and has some underlying assumptions, it doesn't negate that this low efficiency does not bode well for marlin, which must replace weight loss during arduous spawning events or long migrations.

And often only large prey will satisfy the marlin's high energy needs. It is therefore natural that blue marlin would be attracted to the sargassum community, where even a forty-pound dolphin makes a nice snack for a blue marlin. But is there an upper size of prey that a blue can and will eat? According to the following dietary evidence, it appears not. A 448-pound blue marlin, which was caught in the Bahamas, had a 72-inch white marlin in its stomach, and during the 2005 White Marlin Open Tournament, a 70-pound white marlin was found in the stomach of one of the prize-winning blues. Lacking teeth to grasp and cut up its prey—an evolutionary adaptation that distinguishes billfish from its early ancestors—marlin must swallow and consume their food item whole, regardless of its size. And at times when prey is scarce, hungry marlin, being opportunistic feeders, are not likely to pass up any feeding opportunity. But they may pay a price for their ravenous appetites. Harry Fierstine presented the case of a large Atlantic blue marlin that was impaled by two species of billfish, the first recorded incident of a marlin with multiple wounds. Embedded in the marlin's head were two distinct rostral fragments, possibly from a white marlin and a spearfish. Fierstine hypothesized that the multiple stab wounds may have occurred as the result of defensive response by the billfish (he couldn't

determine if the stabbings occurred at the same time) during the predatory act of the marlin.

In contrast, small billfish, such as white marlin and sailfish, are more than content to feed lower on the food chain, consuming smaller organisms, such as the flying fish, which inhabit the tropical and subtropical waters of the Pacific, Indian, and Atlantic oceans. Flying fish can easily be identified by their large, winglike pectoral fins and lopsided tail. This unique anatomical combination permits the flying fish to gain height, extend gliding time, and cover considerable distance after it exits the water. This need for flight, as documented as early as 1791 by John Gabriel Steadman while on a military mission in the tropical Atlantic, is triggered by marauding predators, intent on catching their prey. (The Caribbean island of Barbados has the nickname the "land of the flying fish," and appropriately so since many aspects of Barbadian culture center around this fish: it is depicted on coins, in artwork, and on stamps and is part of the official logo of the Barbados Tourism Authority. While the flying fish has been elevated to a level similar to our own national symbol, the bald eagle, Bajan anglers have no problem incorporating flying fish in their arsenal of baits when targeting billfish—maybe, to the Bajans, an utmost sign of respect.)

Sargassum also piques the interest of offshore anglers, intent on catching that billfish of a lifetime. Their goal is finding well-formed weedlines that may stretch for hundreds of yards and are stacked with large concentrations of prey items. Success in locating sargassum can mean the difference between hooking a hard-charging marlin or telling fish stories back at the dock. With baits deployed, boats cruise the weedline, while captains, mates, and anglers all maintain a vigilant lookout for a determined predator that may rocket out from the sargassum to inhale one of the baits. While not all sargassum patches or lines are alive with life, savvy anglers never pass up the opportunity to explore these drifting havens.

Because of the vital role played by sargassum in the Atlantic ecosystem, the South Atlantic Fishery Management Council (SAFMC), the federal agency responsible for protecting pelagic fish and their habitat from North Carolina to Florida, has declared sargassum as "essential fish habitat" and is charged by law with minimizing any adverse effects

on such habitat. (With the reauthorization of the Magnuson-Stevens Fishery Management Act, Congress included Essential Fish Habitat [EFH] provisions that require all regional fishery management councils to identify and protect EFH—"include those waters and substrate necessary to fish for spawning, feeding, or growth to maturity"). In 2003, SAFMC developed and implemented the Sargassum Management Plan, which places strict limits on the harvesting of sargassum within one hundred miles of the coast. (In the 1970s, a small commercial fleet, based in North Carolina, harvested sargassum, albeit in small amounts, to be processed into nutritive supplements and feed additives. There was concern among federal officials that this burgeoning enterprise would escalate and harvest sargassum at unsustainable levels.)

Bob Shipp, an affable professor of fishery science at the University of South Alabama, frets over another possible long-term threat to the sargassum ecosystem: the massive oil spill in the Gulf of Mexico in 2010. Within his home waters of the gulf, Shipp has been monitoring the vitality of the sargassum that is now mixed with oil. In an interview for *Living on Earth*, he postulates that "sargassum acts almost like a sponge, it just soaks up the oil, and the sargassum is relatively delicate. Once the oil hits it, it'll block out sunlight, it'll essentially suffocate the sargassum and will kill it. And when it does, it kills all the biota, all the life, which is dependent on the sargassum—and there is a lot of it." While fortunately only a third of the Gulf of Mexico was impacted by the oil, leaving vast areas of sargassum virtually untouched, Shipp cautions "that for those areas that have the sargassum covered with oil, it's going to take quite a long time for the other areas of sargassum to come back and replenish those areas of the gulf that have lost their sargassum." Shipp is no ivy-tower academic. As an avid angler himself and frequent contributor to the angling magazine *Sportfishing*, he recognizes the negative economic impacts that the demise of sargassum could have on both the commercial and recreational fishing sectors.

Jim Franks, a colleague of Shipp's from the University of Southern Mississippi, and his team came upon an interesting discovery while taking samples near sargassum weed concentrations in the Gulf of Mexico. While the samples yielded a wide variety of larval and juvenile stage species, which was to be expected, Franks's team was surprised to find sailfish and blue marlin larvae as well—a finding that had not been

documented previously. Although the billfish larvae were not among the most abundant species collected during the sargassum study, the researchers decided to probe deeper into the relationship between sargassum and billfish larvae. It appears that another key variable was the presence of converging water masses that tend to concentrate the larvae. Further analysis of their samples showed relatively low diversity and abundance of larvae found in collections taken near large patches of sargassum not associated with the aforementioned hydrographic phenomenon. They concluded that the larvae may accumulate in converging water masses both with and without sargassum, but the growth and survival of the larvae can be significantly different in both areas. Because sargassum beds serve as nursery sites for many juvenile fish, there is a high probability that billfish larvae there will have a greater chance of surviving and reaching adulthood. Franks believes that this is just another reason for continuing the battle to conserve and protect sargassum as a valuable marine resource.

Tiny Wanderers in a Vast Ocean

While sargassum is one of the largest plants in the ocean, the smallest plants, phytoplankton, play an unequivocally essential role in the community structure and ecological function of modern marine ecosystems. Ranging in size from microscopic to tiny (a cup of seawater may contain millions of these individuals), phytoplankton are the "grasses" of the sea, foundational organisms for myriad life forms in the oceans.

In comparison to billfish, which entered onto the scene relatively late in the earth's history, the first phytoplankton populated the ancient seas more than 1.5 billion years ago. But over time, different species took their turns, kicking in when conditions were optimal for them. By the Mesozoic Era (251 to 65 million years ago), three principal planktonic organisms (diatoms, dinoflagellates, and coccolithophores) would rise to prominence and dominate the modern seas.

Where there is a concentration of phytoplankton, a food chain is set in motion. The phytoplankton are grazed on by zooplankton—small, nonphotosynthetic animals, such as copepods. These shrimplike organisms form the link between the phytoplankton that they consume and still other animals, such as baitfish, that eat these herbivore consumers.

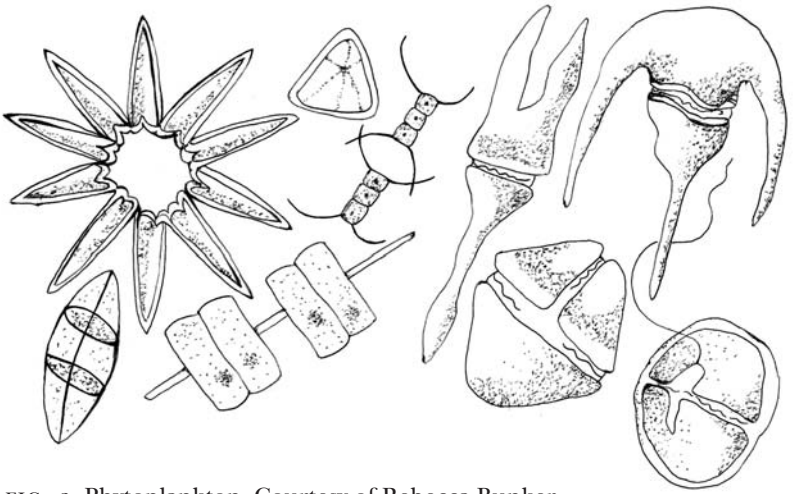


FIG. 3. Phytoplankton. Courtesy of Rebecca Bunker.

And where there are baitfish, soon to follow will be the top predators, like billfish.

Unfortunately, the distribution of phytoplankton meadows is at best sparse and uneven throughout the oceans. Whether or not phytoplankton populate a region depends on the availability of nutrients that arrive at the whim of ocean currents and seawater mixing, which may at times be sporadic or nonexistent.

Very little was known about the location and abundance of planktonic life in the ocean until the pioneering expedition of the German research vessel *Meteor*, which would crisscross the Atlantic from 1925 to 1927. During this period, the ship's biologists routinely collected planktonic samples, which provided essential quantitative data on these tiny wanderers of the sea. For the first time, it became possible to estimate the plankton biomass. But the time-consuming effort of collecting these samples constrained the *Meteor*'s scientists to obtaining information from only a relatively small portion of the vast Atlantic. The big picture would prove elusive for years to come.

The launching of the satellite SeaStar in 1997 opened a new window of opportunity for phytoplankton assessment. Onboard was NASA's Sea-Viewing Wide Field-of-View Sensor (SeaWIFS), which measured the

chlorophyll levels of phytoplankton and algae. Since chlorophyll is an essential pigment found in photosynthetic plants, the measurement of chlorophyll correlates directly to the phytoplankton biomass.

The SeaWiFS images have revealed that huge swaths of the open ocean are biologically poor, lacking any significant concentrations of phytoplankton. These pelagic deserts, though receiving abundant sunlight throughout the year, are depleted of surface nutrients as a result of a permanent, steep thermocline that inhibits vertical mixing.

In contrast, the most biologically productive areas are the coastal regions, which, though comprising only about 10 percent of the ocean area, can have a plankton biomass twenty-five to fifty times greater than the open ocean. One particularly fertile area in the western Atlantic is the coastal Slope Water, a mass of cold, nutrient-enriched water that extends from the shallow Grand Banks of Newfoundland to Cape Hatteras, North Carolina.

Life on the Edge

The boundary between the Slope Water and the western edge of the Gulf Stream is the thermal front—a sharp change in temperature over a relatively short distance. From the cold Slope Water (58°F) to the warm Gulf Stream, the temperature may increase over twenty degrees in only a matter of miles. In addition to a distinct temperature gradient, the thermal front marks a pronounced change in water color—dull green to vivid blue. But its real value is that the thermal front is plant rich due to the infusion of fertile Slope Water. While the Gulf Stream thermal front is a relatively permanent feature in the western Atlantic, transient thermal fronts also occur seasonally but lack the distinct gradients evident in the Gulf Stream front. The location of these thermal boundaries may change over time and distance from the coast as meandering currents and localized winds shift their position. Even subtle variations can often result in dramatic changes in the location and concentration of feeding fish.

To migrating billfish, thermal fronts mean plenty of food. According to Mitch Roffer of Roffer's Ocean Fishing Forecast Service, "If this food chain exists within a game fish's preferred temperature, it's only a matter of time before they find it and stack up in the area." Thermal fronts,

especially those with well-defined edges, can act as a barrier to the movement of billfish. Seeking their thermal comfort zone on the warm side, billfish will move along the edges of a front instead of crossing them. For example, the optimal temperature for sailfish and blue marlin is between 73°F and 82°F, while white marlin can tolerate slightly cooler water (68°F–78°F). In addition, because large concentrations of plankton cloud the water, sight-dependent hunters, such as marlin, will tend to stay on the warm side of the front. Life on the edge abounds; find the edge and you may see bait boiling at the surface, birds diving into this mass of life, and swordfish swimming below all this frantic activity. For those billfish, the ideal situation is when the Gulf Stream interacts with one of the myriad submarine canyons that are found along the eastern seaboard, setting in motion an explosion of planktonic growth.

Captain Dennis Steele, of Stuart, Florida, searches for water that has a certain "liveliness" to it when fishing for sailfish. For him, the two key variables that are critical to a successful sailfish outing are water temperature and color. In particular, Steele searches for blue-green water, which has a temperature that is within the sailfish's comfort zone. If possible, he avoids fishing dull, dirty water that lacks the necessary baitfish to attract billfish. For Steele, a perfect storm of environmental conditions needs to develop to attract the sailfish.

In addition to differences in temperature and color, the difference in current speed along the Gulf Stream's western boundary often creates elongated filaments of warm water, colorfully known as "fingers." Since these fingers are connected to the Gulf Stream in their northern end, the current continuously pumps warm water into them. During the spring and fall, when water temperatures are relatively low west of the Gulf Stream, bait and predators that are migrating along the western edge of the current are found concentrated in these fingers, but they assiduously avoid the relatively cooler water that gets entrained between the fingers and the Gulf Stream. Anglers need to be aware that fingers are not stationary: they slowly move northward with the Gulf Stream at an average rate of thirty miles per day.

Along the western boundary of the Gulf Stream, rotating masses of water, known as frontal eddies, often predominate. They are clearly discernible by their water temperature, current direction and speed, and water color.

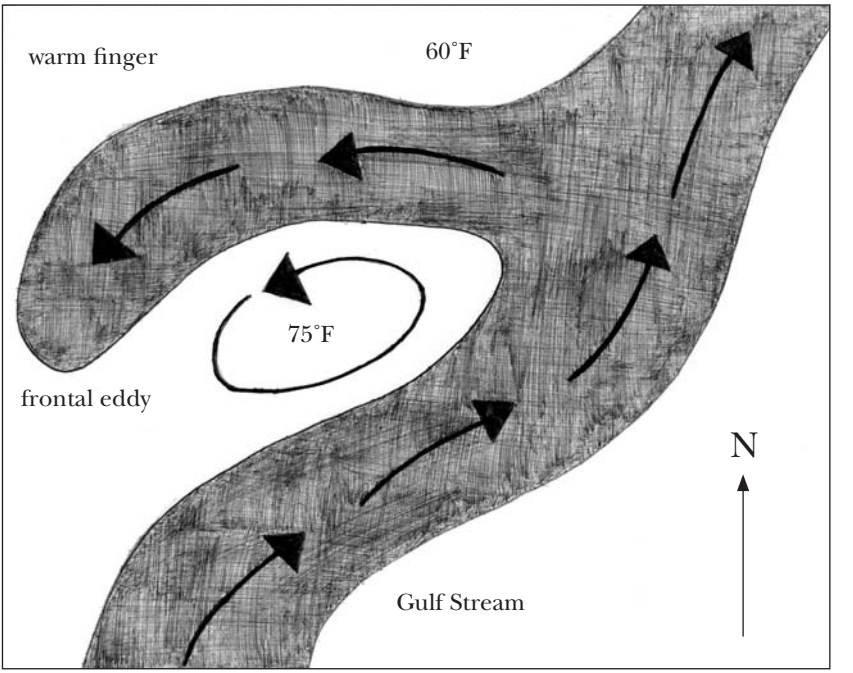
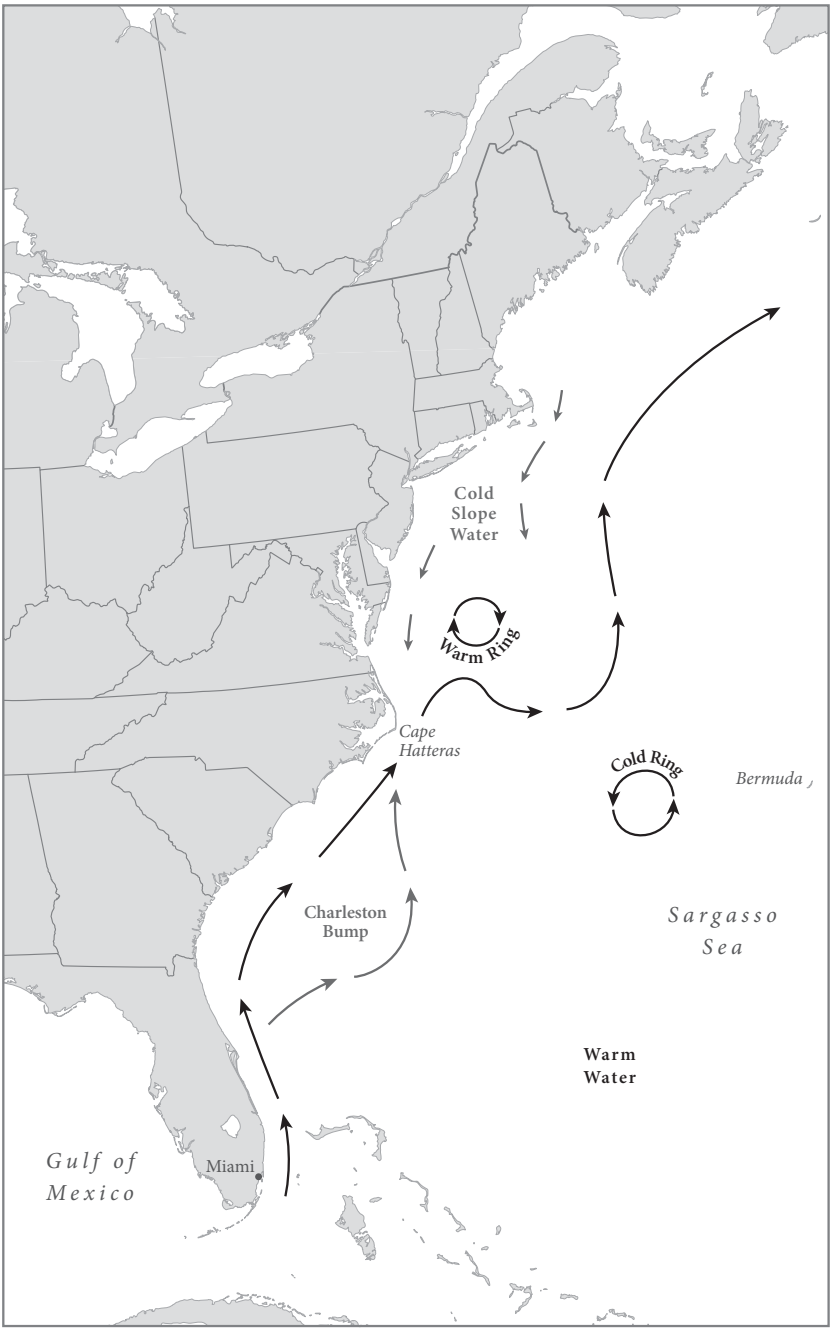


FIG. 4. Frontal eddy and warm finger. Courtesy of Rebecca Bunker.

A counterclockwise-rotating eddy forms when a southward-projecting finger entraps a mass of cold water between itself and the Gulf Stream. The rotation of water around the eddy results in an outward flow of surface water, which is ultimately replaced by upwelling subsurface water. The upwelling eddy infuses the sunlit layer with nutrients, starting a food chain.

A clockwise-rotating eddy forms when a portion of a finger completely separates from the Gulf Stream. While this pocket of warm water lacks both high-nutrient and plant concentrations, during the spring, pelagic species may concentrate here, since the surrounding water remains cold.

The larger cousin of an eddy—a ring—develops when a current meander bends sharply and forms almost a complete loop. At times, the pinched loop may separate from the main flow, much as an oxbow lake forms from a meander in a river, resulting in a closed, self-contained



MAP 2. Gulf Stream Flow along the Eastern Seaboard

ring. As each ring develops, a column of water is appropriated from one side of the Gulf Stream and transported to the other side—a region of distinctly different physical, chemical, and biological properties.

Warm-core rings, for example, are clockwise-circulating masses of water that are found inshore of the Gulf Stream and are surrounded by colder Slope Water. In contrast, cold-core rings spin counterclockwise and are embedded in the warmer water of the Sargasso Sea. Throughout the year, the Gulf Stream may shed anywhere from ten to fifteen rings. Because warm-core rings are home to a variety of tropical and subtropical planktonic species, which were incorporated into the ring from the Sargasso Sea, a food chain develops in a relatively short time. Due to their proximity to the coast, these warm-core rings are frequent targets for offshore anglers, who may be reluctant to make the longer trip across the Gulf Stream to the cold-core rings.

Targeting Billfish

Since the distribution of food throughout the Atlantic is spotty, "place" is at the essence of locating billfish. These fish seek out sargassum weed lines, sea surface temperature gradients, eddies, and water color changes, to name a few, all of which, at times, could hold the prey that billfish seek. As in real estate, where location, location, location is the overriding principle, finding the right location is the key to successful billfish angling. Over the years a number of commercial enterprises have popped up that offer daily, up-to-date fishing forecasts. The forecast analyses, which incorporate myriad biological and physical oceanographic data, including satellite images, are designed to allow anglers to concentrate their effort in the most productive waters.

And to many hard-core billfish anglers, the Gulf Stream is the premier destination in the Atlantic, the site of great schools of baitfish and the prowling sailfish and marlin that feed on them. To Captain Albert Johnston, who has explored and fished many of the great bodies of water of this world, the Gulf Stream stands out—the place to fish if he had to choose only one. And to back up his ranking, the Gulf Stream off of Palm Beach, Florida, yielded a record eighty-three sailfish to Johnston in one day of fishing.

Early praises for Gulf Stream fishing came from no less an authority than Ernest Hemingway, who was ahead of his time in developing innovative angling techniques to catch record-setting billfish. In a 1936 article ("On the Blue Water: A Gulf Stream Letter") for *Esquire* magazine, Hemingway argued that fishing in the Gulf Stream ranked above big-game hunting on the African plains. "In the first place, the Gulf Stream and the other great ocean currents are the last wild country that is left. Once you are out of sight of land and other boats you are more alone than you can ever be hunting and the sea is the same as it has been since men ever went on it in boats." To Hemingway, the Gulf Stream was a mystery, reluctant to give up its secrets: "Because the Gulf Stream is an unexploited country, only the very fringe of it ever being fished, and then only at a dozen places in thousands of miles of current, no one knows what fish live in it, or how great size they reach, or what age, or what kinds of fish and animals live at different depths." Hemingway, over his lifetime, would consistently sing the praises of the Gulf Stream, making this great flow accessible to a public hungry for adventure through his writings, such as *Islands in the Stream* (1950–52; published 1970) and *The Old Man and the Sea* (1952).

While even Zane Grey, known primarily for his chronicles of the American Old West, also extolled the virtues of Gulf Stream angling (*Fishing in the Gulf Stream*, 1922), this current is not alone in attracting concentrations of billfish. For years, blue-water fishing in the Gulf of Mexico had been overshadowed by the record-setting exploits of Gulf Stream anglers. While Hemingway and Grey were routinely catching Gulf Stream marlin and sailfish in the early part of the twentieth century, it wasn't until 1949 that the first blue marlin was taken in the Gulf of Mexico. In his book *Atlantic Game Fishing* (1937), S. Kip Farrington recorded that a few marlin succumbed to the gaff off Port Island, Texas, with a 326-pounder being the biggest. But marlin fishing really didn't catch fire with Gulf Coast anglers until the mid-1950s, when the results of a biological survey of the Gulf of Mexico, conducted by personnel from the Woods Hole Oceanographic Institute, would filter their way down to the public. As chronicled by Jan Fogt in his article "The Forgotten Coast," the two lead researchers, Frank Mather and Howard Schuck, set out different types of commercial fishing gear. Their best

haul—sailfish, swordfish, white and blue marlin—occurred only eleven miles offshore from the mouth of the Mississippi River. While word about this remarkable catch spread rapidly through the angling community, ultimately leading to a robust marlin fishery, Mather and Schuck pondered why there was a relatively high concentration of billfish in close proximity to the Mississippi River. They quickly dismissed this finding as being a random event in light of the fact that the mighty Mississippi, which drains the American heartland, supplies the gulf waters with nutrients, which Mather and Schuck instinctively knew would set the stage for the appearance of baitfish, to be followed by hungry predators.

Underwater structures—canyons, sills, and plateaus—also draw in baitfish. In the Caribbean basin resides an underwater ridge known as La Guaira Bank. Located approximately twelve miles off the coast of Venezuela, this bathymetric feature extends twelve miles in an east-west direction and four miles from north to south and it rises more than seven hundred feet from the seafloor. This imposing structure acts as barrier to the westward flowing Caribbean Current, which has branched off from the North Equatorial Current, the southern limb of the North Atlantic gyre, and creates an upwelling environment in which nutrients are brought up to the ocean surface from their deep-water stockpiles. The plethora of nutrients fuels an explosion of planktonic growth, which ultimately attracts high numbers of blue marlin, white marlin, sailfish, and spearfish that congregate at different seasons, making La Guaira one of the top billfishing destinations in the world. It is probably not a stretch to claim that La Guaira, as do many other sites in the Atlantic, owes its angling prominence to the inconspicuous phytoplankton.

3

Billfish through the Ages

More than ninety years ago Zane Grey generated considerable interest in billfish with the publication of his book *Tales of Fishes* (1919), stories of his worldwide fishing adventures.

> Suddenly my line rose—and then, bewilderingly near the boat, when I was looking far off, the water split with a roar and out shot a huge, gleaming, white-and-purple fish. He blurred in my sight. Down he went with a crash. I wound the reel like a madman, but I never even half got up the slack line. The swordfish had run straight toward the boat. He leaped again, in a place I did not expect, and going down, instantly came up in another direction. His speed, his savageness, stunned me. I could not judge his strength, for I never felt his weight. The next leap I saw him sling the hook. It was a great performance. Then that swordfish, finding himself free, leaped for the open sea, and every few yards he came out in a clean jump. I watched him, too fascinated to count the times he broke water, but he kept it up till he was out of sight on the horizon.

But human fascination with billfish dates even earlier, well back into antiquity. Fishing for swordfish first occurred during the Bronze Age, which began in the fourth millennium B.C. and marked a period in civilization with the development of relatively sophisticated metallurgical techniques that yielded more complex tools. That the swordfish was often viewed as a revered creature even in the time of the Greek poet Homer (ca. 850 B.C.) gains credence by the existence of an ancient legend found in Greek mythology. It tells of how the Myrmidons, followers of Achilles, took part in the Trojan War, in which Paris treacherously kills Achilles. Seized by rage and despair for their fallen leader, the Myrmidons throw themselves into the sea. Thetis, Achilles' mother

and a minor sea goddess, transforms them into fish. In recognition of their sacrifice, she allows them to keep their swords but changes them into long bills on the snout. Thus, according to legend, was born the swordfish.

Aristotle (384–322 B.C.), who made numerous contributions in mathematics, logic, ethics, physics, and biology, saw his arduous research in the natural sciences culminate in *Historia Animalium*, which is considered by many historical scholars the greatest scientific tome of ancient Greece. With regard to Aristotle's treatment of animal biology, there would be nothing comparable for another two thousand years.

Included in Aristotle's vast zoological research were swordfish, which he called *xiphias* (the sword). These highly migratory species periodically entered the Mediterranean Sea through the Strait of Gibraltar and could be found as far eastward as the Ionian Sea near Greece. There was no need for early seafarers to venture far beyond their home waters to observe these billfish; they were at their coastal doorstep.

Aristotle noted that "swordfish are tormented as a dog by a gadfly, by a worm under the fins, which looks like a scorpion, has the size of a spider, and causes such anguish that not infrequently the swordfish jumps out of the water like a dolphin, even falling into the boat." The insidious pest that Aristotle was describing is a parasitic copepod, not to be confused with the planktonic variety. Though Aristotle was the first to record the existence of this organism, scientists have documented over 1,600 species of this nemesis, which is found even today quite frequently on tuna, and always near the fins.

Polybius (203–120 B.C.), a Greek historian, describes in his *Histories* hunting for swordfish. As recorded, outings took place on the rock of Scylla (an underwater structure named after a Greek sea monster goddess), which is located in the Strait of Messina off the coast of Italy. Two men set out in a small, flimsy boat that was usually built and painted to resemble a swordfish. (This Trojan swordfish gambit persisted through Roman times, but when the fishermen realized that their artistry had little influence on piquing the curiosity of a swordfish, it was soon abandoned.) In the boat, one man rows, and the other stands ready with an *arpione*—a harpoon with a barbed and detachable metal head. When a swordfish is sighted, the oarsman rows the boat as near to the fish as possible, allowing the harpooner to strike it at close quarters.

If the harpooner's aim is accurate, the barbed head of the harpoon attains purchase in the fish's flesh. A shaft on the harpoon with a long rope attached to it allows the men to control the wounded fish until its struggles cease, and it can be hauled back to land, or, if its size is not too great, into the boat. Each outing was preceded by paying homage to the sea god Poseidon, who combed the ocean depths with his own three-pronged spear. Poseidon must have looked favorably on his human subjects because Polybius described that the fishermen were quite successful in their swordfish hunts.

The Roman historian Pliny the Elder (24–79 A.D.) followed in Aristotle's footsteps with his exhaustive thirty-seven volumes of *Natural History*, of which volumes seven through eleven covered zoology—everything from people to fish to bugs—and which also relied strongly on the teachings and writings of Aristotle. Pliny was probably the first author to assign anthropomorphic characteristics to his animal subjects, introducing the swordfish as a belligerent. He writes "that the *Xiphias* or, in other words, the swordfish, has a sharp-pointed muzzle, with which he is able to pierce the sides of a ship and send it to the bottom, instances of which have been seen near a place in Mauretania."

But modern historians accuse Pliny of being negligent in fact checking and verifying what he wrote. Among the bizarre wonders he described were of a monumental battle between an elephant and a dragon and of a boy who rode to and from school on a dolphin's back. One scholar simply described Pliny as "endearingly batty."

So what are we to make of Pliny's pugnacious swordfish? Do they really have a surly attitude, which manifests itself in their wanton attacks against vessels? As nations sent their ships farther out into the vast seas of the world in search of new trading partners or for the conquest of hostile neighbors, eyewitness accounts of swordfish forays against ships became more prevalent.

Before his naval victory at the Battle of Lepanto (near western Greece) in 1571 against the Ottoman Empire, Don John of Austria, a military leader in service to his half-brother, Philip of Spain, had positioned his ships in the Strait of Messina. Intent on resupplying his ship, Don John ordered his crew to hunt for swordfish. Six swordfish were harpooned, one of which, as a combat correspondent reported, "was not very much resigned to die, and it launched itself against his

boat and pierced it from side to side." In its struggle to free itself, the swordfish broke off its bill, which was pried loose from the ship's hull by Don John and which became a symbol of the crew's fishing prowess. (At times, present-day tournament anglers remove the bill of a prize-winning marlin for a trophy, which to some observers is only a grisly reminder of the death of this magnificent creature.)

The crew of the whaling vessel *Fortune* would see firsthand the raw power of a swordfish. Upon making port to unload the ship's cargo of oil in 1826, a keen-eyed dock worker spied the bill of a swordfish, which had become lodged in the hull. To everyone's amazement, it soon became apparent as to the magnitude of this event. The bill had penetrated the hull's copper sheathing, one inch of board sheathing, a three-inch hardwood plank, twelve inches of the ship's oak timber, two and a half inches of oak ceiling, and a cask of oil, which it plugged as neatly and effectively as a cork.

One enterprising mathematician, Harlon Major, determined that a five-hundred-pound swordfish must attain a speed of fifty-seven miles per hour to pierce through eighteen and a half inches of wood.

According to Zane Grey in *Tales of Fishes*, Professor Richard Owen, while testifying in an English court on the power of a swordfish, offered this very colorful opinion: "It strikes with the accumulated force of fifteen double-headed hammers. Its velocity is equal to that of a swivel shot, and is as dangerous in its effect as a heavy artillery projectile." In the same vein, Grey further wrote that the *London Daily News* of December 11, 1868, reported on a rather odd hearing in the court of common pleas: whether a swordfish that had thrust its prodigious snout into a ship's side could figuratively swim off from any responsibility. The ship in question was the *Dreadnought*, which had been insured for three thousand pounds. The crew had hooked a swordfish, which upon promptly breaking the line, decided to take revenge on its persecutor by attacking the vessel. The captain was soon made aware of the unwelcome news that the ship had sprung a leak and was rapidly taking on water. Disabled, the vessel was taken back to port, and an inspection did indeed reveal a round hole, an inch in diameter, running completely through the copper sheathing and planking.

Though the ship's insurance policy covered even swordfish attacks, the insurance company steadfastly refused to honor the claim, arguing

that there were no recorded instances where a swordfish had not lost its beak upon passing through inches of planking. A Mr. Buckland, an insurance executive, ultimately admitted that a swordfish has considerable lateral movement and might be able to "wiggle its sword out of the hull." The case was ultimately settled in favor of the plaintiffs for the tidy sum of six hundred pounds, the result of an ill-tempered fish.

Such stories became rampant throughout the nineteenth century, a period of fast, wooden sailing ships. But even modern-day vessels have had their share of encounters with swordfish. On July 6, 1967, the research submersible *Alvin*, based at the Woods Hole Oceanographic Institute, was attacked and rammed by a swordfish at a depth of two thousand feet during a geological survey of the Blake Plateau off the east coast of Florida. Edward Zarudzki, a scientific observer on the mission, spied a "large fish, apparently captive, violently trying to disengage itself and in the process tearing some of the skin and flesh off its back." The swordfish had wedged its bill into the junction between the upper and lower parts of the fiberglass external hull, thus causing a slight leak in one of the electrical junction boxes outside the hull. Fearing additional damage, *Alvin*'s pilot decided to surface. While *Alvin* was being hoisted out of the water, the swordfish violently struggled again, breaking off its sword. It took a crew more than two hours to remove the bill from what was determined to be a relatively small specimen (196 pounds) of *Xiphias*.

Pliny's vindication notwithstanding, the Romans harbored almost a mystical reverence for the swordfish, bestowing it with the name *gladius*, the Latin word for "sword." The gladiators of ancient Rome fought other men or animals with a sword in an arena for the entertainment of spectators. Did the Romans view the swordfish as the gladiator of its watery realm? Aelian (170–230) recorded that the swordfish fed by flailing among smaller fish with "its sword-shaped rostrum." Interestingly, Aelian's anecdotes on animals, which would culminate in his massive work *On the Nature of Animals*, rarely depended on direct observations; they are most likely from other sources. He was said to have boasted then that he had never been aboard a ship and knew little of the seas, but often quoted "fishermen."

On a more ominous note, the attempted capture of a swordfish in the Mediterranean Sea periodically led to the impalement of a careless

boatman, struggling to bring onboard a harpooned, but still very much alive, swordfish. Was the gladiator of the sea fighting back against its antagonist?

Centuries later, Zane Grey picks up the theme of the pugnacious nature of swordfish in *Tales of Swordfish and Tuna* (1927): "In these waters, where he is hunted for the market, he has often killed his pursuers. In the Pacific, off the Channel Islands, he has not killed any angler or boatman yet, but it is a safe wager he will do so some day."

For a period of almost five hundred years, the Roman Empire spread and endured throughout much of Western Europe and the Mediterranean. While an autocratic form of government predominated in Rome's vast holdings, the institutions and culture of Rome had a profound and lasting influence on the development of religion, architecture, philosophy, law, and language. The French word *empereur* ("emperor" in English) and the Portuguese word *imperator* (derived from the Latin word *imperador*, a title conferred on Roman emperors) reflect the influence of the conquering Roman emperors, who were often represented by artists and sculptors holding a drawn sword in their hands. Before the swordfish came to be known by its current scientific name, *Xiphias gladius*, two taxonomists, M. E. Bloch and J. G. Schnieder, formally referred to the swordfish in 1801 as *Xiphias imperator*.

Half a world away, the Polynesians recognized the gladiatorlike nature of the swordfish and other billfish. In the early 1700s, they were crafting weapons made from the bills of these species. The bills would be hand polished and lashed to wooden handles by means of coconut fibers woven together to form a cord. The finished bills were used as knives, spikes, daggers, and, yes, swords to subdue enemies.

Though historians and scientists have accurately reported on what I believe can be viewed as an iconic species, there have been some wrong turns in the swordfish lore. The eminent naturalist Henry Fairfield Osborn wrote a statement in 1931 to the effect that Christopher Columbus had placed the rostrum of a swordfish, which was killed on his first visit to the New World, in a church in Siena, Italy. Though there is an inscription in the church that attributes other artifacts (sword, buckler) and the specimen in question to the generosity of Columbus, visual evidence reveals that the specimen is obviously a mammalian

scapula and not part of a fish. The scapula's fanlike shape is characteristic of a cetacean, possibly a common finback whale. Though there is no evidence that would confirm or negate that the scapula was originally in the possession of Columbus, Samuel E. Morison, for example, does not mention the incident in his detailed biography of Columbus, *Admiral of the Ocean Sea*. But at least we can state unequivocally that the "swordfish" of Columbus was a whale.

Billfish in the Modern World

Notwithstanding these few setbacks, the stature of the swordfish and other billfish would rise meteorically at the end of the nineteenth century, spurred on by the advent of sport fishing for large, pelagic species. It is not a far stretch to state that the history of big-game fishing and the history of the Tuna Club of Avalon on Catalina Island are inextricably intertwined. In the waters of this remote island off the coast of California is where the world's first rod and reel capture of tuna, marlin, and swordfish took place and generated national attention. All the essential ingredients came into place to make this stretch of the California coast a mecca for the pursuit of big, strong, and fast fish: abundance of large fish, the evolution of fishing tackle, and the arrival of men who had the vision, tenacity, and skill to catch these fish successfully.

One of these visionaries was Charles Holder, an accomplished author, sportsman, and naturalist from Massachusetts. Drawn to the opportunities and adventure that a growing West offered, Holder settled in Los Angeles, but spurred on by his incurable curiosity of the natural world, he would visit the remote island of Catalina in 1886. He was astounded by the diversity of marine life: sea bass and yellowtail frantically chasing bait; seabirds whirling overhead; sea lions lounging on the rocky shore; and whales breaching the sea surface.

This cornucopia of life speaks volumes to the fertility of the water. Seasonal winds set in motion the movement of warm surface water from the coast, which is replaced by cold water that has upwelled from the depths. Loaded with essential nutrients, the water stimulates the growth of phytoplankton, which Holder, ever the inquisitor, recognized as the quintessential foundational organism for the many forms of marine life that he observed.

This bountiful body of water also attracted fishermen, who threw baited handlines into schools of feeding fish. The method was so effective and indiscriminate that Holder was compelled to write, as documented by Michael Farrior in his excellent book *The History of the Tuna Club, 1898–1998* (2004), that he was "amazed and horrified at the sight of men fishing with handlines from the beach, pulling yellowtail from twenty-five to thirty pounds as fast as they were able to cast." He argued to whoever would hear his words that this type of fishing was tantamount to wholesale slaughter, an inequitable match that pits man against fish.

He lobbied steadily for a more sportsmanlike approach to angling: the use of a rod and reel to catch true behemoths, which frequented these waters. In particular, bluefin tuna arrived in such great schools that when they fed, their feeding frenzy would literally churn up acres of frothy, white water that could be seen from a considerable distance away.

After suffering through a few disappointing seasons during which Holder was unable to catch a tuna, partly as a result of his inexperience with such large fish, in 1898, he successfully boated a 183-pound tuna, which was enthusiastically recognized by his angling companions as the first "very large one." News of his accomplishment spread quickly, and for the first time, the public took a keen interest in big-game fishing.

Buoyed by his angling feat, Holder, with the assistance of his colleagues, founded the Tuna Club in 1898, whose goals were to promote sportsmanship, to elevate the sport to its highest possible standard, and to ensure the protection of game fish throughout Southern California. The club's motto of "Fair Play for Game Fishes" was unanimously endorsed by boat captains and anglers. Any infraction of the club's rules could, and did, lead to anglers losing their club membership.

It is interesting to speculate on Holder's obsession with ethical angling standards. As an easterner who learned to fish the creeks and rivers of New England for trout, Holder may have been influenced by the thinking of Izaak Walton. In his seminal work, *The Compleat Angler* (1653), Walton avidly promotes the sport of angling from a social and moral aspect. His passion for the sport is evident when he wrote, "God never did make a more calm, quiet, innocent recreation."

Even with the strict code of angling conduct in place, the Tuna Club attracted sportsmen, personalities, and dignitaries from all around the world, each intent in doing battle with one of nature's wild creatures,

PHOTO 3. Avalon Tuna Club. Copyright Istockphoto.com / rarpia.

which now included marlin and swordfish. From the political spectrum, the guest list included Theodore Roosevelt and Winston Churchill. In addition, there were several Hollywood entertainers, such as Jackie Coogan, Charlie Chaplin, Bing Crosby, and Stan Laurel, who were members. The latter demonstrated that his fishing prowess was just as impressive as his comedic genius by catching a 258-pound swordfish in 1936.

Twenty-three years before Laurel's catch, the first swordfish fell victim to an angler, a William Boschen. He would define the art and the Herculean labor required to subdue a swordfish in this sporting manner. On August 23, 1913, off Catalina, Boschen caught his prize billfish of 358 pounds on rod and reel. He was able to subdue the fish in only about an hour and half, a testament to his skill and strength. His captain, George Farnsworth, exclaimed that "he was the strongest man I ever knew." It was said that when the fish was hoisted to the dock at Avalon, it came back to life, broke the rope, smashed the weighing

standards, and swept the end of the dock into the water. While this episode may have contributed to the overall legend of the swordfish, there is little historical doubt about the legendary status of Boschen during the early part of the twentieth century. No less an angling authority than Zane Grey would in his writings praise Boschen as a superb angler. Grey was of the opinion that swordfishing required more skill, nerve, endurance, and strength than hunting grizzly bear or stalking the fierce tropical jaguar, both of which he had done. But only Boschen had truly mastered the technique of subduing the swordfish in a fair battle. By the time Boschen died in 1919, he had caught eleven swordfish, one of which was a world record 463 pounds.

In contrast, Grey, a man who was relentless in his pursuit of swordfish, suffered many frustrations. Once, for example, he spent ninety-three days fishing off of Catalina. During that time, he sighted 140 fish, presented a bait to 94, hooked and fought 11, but caught only 4.

In spite of his less than stellar record in boating swordfish, as an early member of the Tuna Club, Grey was still an avid proponent of swordfishing, spreading the gospel of big-game fishing far and wide. On the occasion that his brother caught his first swordfish, a thousand spectators turned out for the weighing of the fish back at the dock. (Psychologists may have a field day analyzing what is the mass appeal of viewing a dead fish, unceremoniously hanging by its tail, but the myriad billfish tournaments along the eastern seaboard today still attract thousands of spectators, many with camera in hand.)

During his stay on Catalina Island, Grey was laser-focused on swordfishing to the exclusion of all other angling activity. On his boat, he rigged only one rod and was adamant that the cockpit be kept clear of any extraneous gear that was not essential to catching swordfish. He preferred cruising, searching for fish, rather than blindly dragging baits with the hope that something else will be caught while waiting for a swordfish to surface. To aid in his ability to see swordfish, he installed a platform about two-thirds up the boat's mast. From this crow's nest, Grey was also able to deploy his bait with less trailing line and leader, excess of which may spook a wary fish. His line ran far astern before touching the water, and the captain was able to keep the boat a greater distance from the fish. Despite the drawback of an angler having to climb down quickly, sometimes in rolling seas, to fight a freshly hooked

fish, Grey claimed that this setup was very effective in eliciting strikes from cruising swordfish.

Many of these early catches were remarkable considering the tackle these pioneering anglers routinely used. The three-piece hickory rods were prone to breaking at the ferrule—the male and female joints of a fishing rod. The linen lines were either not strong enough for swordfishing or prone to wearing out during a prolonged fight. Although the reels generally had enough line capacity and were beautifully machined to ensure their durability, one of the major downsides of their construction was that they were direct dive. This meant that when a hooked fish made a determined and long run, taking hundreds of feet of line with it, the handle would spin backward, earning these reels the dubious nickname "knuckle busters." Modern reels, in contrast, have a mechanical means of slowing down a runaway fish, applying the "brake" to the fish. With regard to those early reels, the brake consisted of a leather pad, fixed to the rear pillar, which the angler pressed against the rotating spool using his thumb to create a drag.

Realizing the severe limitations of their tackle, members of the Tuna Club were at the forefront of tackle development. The Tuna Club became the perfect place to experiment with tackle innovation. In this matter, William Boschen would again be out in front of many of his peers. He is credited with the original concept for the internal star drag reel, which allowed the angler to exert significant pressure on a fish. A prototype was made in Brooklyn, New York, by reel manufacturer Julius vom Hofe and was used by Boschen to catch that first swordfish on rod and reel. (Vom Hofe, in honor of Boschen's catch, wanted to name the reel after Boschen, but Boschen modestly refused, so they compromised on the name B-Ocean.)

In 1911, Captain George Farnsworth introduced the practice of suspending a bait (flying fish) from a kite as the best means of keeping the bait away from the boat. Previously, the boat's noise and shadow had spooked skittish fish, causing them to sound; so that only a limited number of fish were enticed to strike. Kite fishing enabled a boatman to steer well clear of a school of fish while keeping the angler's bait skipping enticingly over the water surface. Farnsworth originally applied his innovation to improve his catch of tuna that would gather in massive schools in the waters off of Catalina, but

kites would over time become a staple of Florida anglers targeting Gulf Stream sailfish.

On July 1, 1919, Zane Grey's brother, R.C., hooked a swordfish estimated to be well over seven hundred pounds. Over an eleven-hour period, R.C., Zane, and the captain, Danielson, all took turns on the rod but were unable to subdue this giant. Finally, after fighting the fish for half a day, the line parted, and the epic battle was over for the three weary anglers. The outcome of the event convinced Grey that heavier tackle was needed for these powerful fish. While light-tackle fishing most assuredly had its place in the angling world, Grey was appalled to think of a large fish swimming off with a hook embedded in its mouth and trailing yards of leader and line behind it because the line was too light.

Grey petitioned the Tuna Club to allow him to use heavier line when targeting swordfish. He was adamant, both in his writings and public appearances, that this approach was the only way to go in the pursuit of big fish and was also in line with the club's goals. At that time, club rules limited anglers to the use of twenty-four thread line (each thread had a maximum breaking point of three pounds). The Tuna Club steadfastly refused to grant the use of heavier line—rules were rules—so Grey abruptly quit the club. (Other evidence suggests that Grey was not popular among the Tuna Club's members, prone to egotistical outbursts about his trophy catches. In 1921, Mrs. Keith Spalding caught a 426-pound swordfish, which Grey immediately declared was not caught single-handedly by such a small woman. Outraged by his unsubstantiated claim, club members petitioned Grey to resign.)

Regardless of the reason why he left the club, Grey, by the 1920s, was routinely using tackle that he was certain was more sportsmanlike and fairer to the swordfish. He had a famous Coxe reel especially manufactured for him, which he paid the exorbitant amount, for its time, of $1,500. (Grey often wrote that the pursuit of swordfish was an expensive undertaking.) The reel was much sturdier and larger than those in current use, allowing Grey to pack on more line. He also had special lines made: thirty-nine thread, four hundred yards long. All this gear was to be used for swordfish alone. In 1926, Grey proved his detractors wrong, catching a 582-pound swordfish with the heavier tackle.

Grey found additional support that heavy tackle was the only sporting way to catch swordfish from Henry Adams, who was considered by

the Tuna Club to be their greatest angler. "These twenty-four thread lines are not strong enough for swordfish over three hundred pounds," he related to Grey. "I think you are years ahead of all of us. Now I want you to sell me one of your thirty-nine thread lines. I'll use it, and when I catch a broadbill I will call a meeting of the directors of the Tuna Club and tell them flatly that you are right and they are wrong." Club members would recognize, albeit slowly, the logic of Grey's arguments and come around to his side.

Grey, who was known to fish three hundred days of the year, did not confine his fishing efforts to swordfish when not on the West Coast. In the winter of 1911, Grey vacationed on Long Key, Florida, while writing his novel *The Light of the Western Stars*. At that time, fishing for king mackerel (called kingfish by Grey) was the popular sport among the locals and visitors. Sailfish, which were incidentally hooked when fishing for king mackerel, were considered a nuisance, known to steal bait intended for the king mackerel and were unflatteringly called "boohoo."

But by 1916, Grey had convinced many of the naysayers that angling for sailfish was indeed a worthy sport. Ultimately, his admiration for the fighting ability of the sailfish would manifest itself through his writings in *Tales of Fishes*: "It is not easy. On the contrary, it is extremely hard. It takes infinite patience, and very much has to be learned that can be learned only by experience. But it is magnificent sport and worth any effort."

While sailfishing drew in more and more participants over time, a controversy, similar to the one in the Tuna Club, over which tackle to use would split the angling community. (This recurrent theme of confrontation on Grey's part appears to be the result of his strong, willful personality and, according to some of his biographers, an oversized ego.) Grey was of the opinion that the size of the tackle should match the quarry. He was able to show the efficiency of light-tackle fishing by catching four sailfish in one day, a feat that caught the attention of his detractors. He argued that if the angler demonstrated great care and skill, a nine-thread line and six-ounce rod tip were strong enough to take a hard-jawed, wild-leaping sailfish.

Grey considered it brutal to haul in a fish on tackle so heavy that it has no chance for survival, but he also expressed the belief that the

PHOTO 4. Acrobatic sailfish. Copyright Istockphoto.com / Darren Pearson.

use of too light a tackle was just as sinister: if the fish does not break the line, it must be fought for hours on end until it practically dies of exhaustion. The principle that Grey would espouse throughout his life is that the angler should subdue the fish by his skill with rod and reel and possess the strength to end the battle in a sporting manner. This theme of using the correct tackle would be repeated more than thirty years later by Ernest Hemingway, drawing on his Gulf Stream fishing experiences, documented in *Hemingway on Fishing*: "We could catch fish with the lightest tackle, I believe. It would prove nothing, since others have done it, and we would break many fish off to die. Our ideal is to catch the fish with tackle that you can really pull on and which still permits the fish to jump and run as freely as possible."

As Grey saw it, the tackle controversy at Long Key stemmed from the fact that the interests of many charter-boat captains centered on as big a catch as possible for each angler they took out. Heavier tackle ensured putting fish in the boat, and more fish meant happy anglers,

who, in turn, were all the more willing to generously tip their captain. Grey viewed it as criminal that tons of game fish were brought in only to be thrown to the sharks. Even Hemingway, who developed a reputation for machismo by his pursuit of behemoth fish, bemoaned that as long as both captains and their anglers wanted results above everything else, then big-game fishing would be closer to an all-out war against big fish than sport. Hemingway's musings may have their roots in English fishing literature of the eighteenth century. These authors espoused that fishing is a battle with nature and were quick to jettison anything to do with introspection and connecting with nature.

Grey would ultimately use the Long Key Fishing Club, where he served as first president from 1917 to 1919, as a venue to publicly spread the word about sportsmanship in big-game angling. The goals of the club included the development of the finest traits of the sport as well as imposing restrictions on the killing of fish. With regard to the latter, the club members agreed that two sailfish a day was a reasonable catch for any angler. By 1929, club membership had grown to 133 and included President Herbert Hoover as an honorary member. The rich and famous who partook of the club's amenities, including a hotel, cottages, post office, and a fleet of boats, were committed to keeping Long Key as the premier location in Florida for big-game fishing.

What made Long Key so special was its proximity to the Gulf Stream, the conduit and feeding ground for sailfish, king mackerel, and other fish. As the current surges northward, it is no more than about five miles from the coast. From his home port, Grey could reach the Gulf Stream by navigating through openings in the shallow reef that buttressed the coast. For a stretch of about eighteen miles the Gulf Stream runs along the outer edge of the reef, and on many days, Grey observed the dark, indigo-blue water of the current in contrast to the light green water of the reef. The dark, warm current with its flow of several miles per hour is where Grey would put out his baits. But Grey would soon learn that the Gulf Stream is an indiscriminate conveyor of many forms of marine life, from the angler's perspective, both the desirable and despised. Barracuda, armed with a formidable array of teeth, are notorious for attacking bait intended for "higher-level" game fish. Grey countered the attacks of barracuda by first introducing wooden teasers for sailfishing in the Florida Keys to alleviate the tedious chore of replacing bait

teasers destroyed by barracuda. (Teasers would become a staple in the tackle arsenal of many current billfish anglers.)

This idyllic setting at Long Key would be impacted by a hurricane, packing winds of over 180 miles per hour, which bore down on the Florida Keys in 1935, destroying much of the Keys' infrastructure, including the railroad that linked the mainland to these isolated cays. Due to the hurricane's wrath, the club was discontinued in 1935 but was later reorganized in 1969 by Del Layton, a Miami grocery-store magnate.

A Changing of the Guard

But by 1935, Ernest Hemingway was creating his own storm in the world of big-game angling—routinely catching huge marlin in the waters off of Cuba. At this period, Zane Grey was in his twilight years of catching trophy fish, but ever the self-promoter, Grey challenged Hemingway to a round-the-world fishing competition. Hemingway's light was just beginning to burn bright, and he saw no value in linking up with a dying ember. He flatly refused Grey's offer.

Though Hemmingway first visited Cuba in 1928 during a layover to a trip to Spain, it was not until 1932 that he went to Cuba with two friends from Key West, Joe Russell and Joe Lowe, to fish the annual marlin run. A year later, Hemingway was writing for *Esquire* magazine, and he would use fishing outings as material for his articles, opening up a whole new world to shore-bound readers. While Zane Grey and others wrote primarily to the angling fraternity, Hemingway wrote for the uninitiated, filling in the gaps to elevate their understanding of big-game fishing, as well for the aficionados.

During the fishing season of 1933, Hemingway, accompanied by his mate Carlos Gutierrez, was aboard the boat *Anita*, which was captained by Joe Russell and docked in Havana. Hemingway viewed Gutierrez as the best marlin and swordfish angler around Cuba, a good match for the competitive Hemingway. They had met in 1927 in the Dry Tortugas, where Gutierrez regaled Hemingway with stories of the annual big marlin run off of Cuba. Though now fifty-eight years old, Gutierrez had religiously studied the habits of marlin—a fact that Hemingway readily admits made a big impression on him, and a practice that Hemingway

would soon adapt on his own—since Gutierrez had gone fishing for them as a boy of twelve with his father.

Gutierrez would teach Hemingway how to rig baits at different depths for marlin fishing—a totally new concept for Hemingway. When no fish were at the surface, they employed eight hundred yards of eighty-five-pound test monel wire, which was fished from high-capacity Hardy reels and rods. This combination allowed a baited feathered jig to be fished at depths of over thirty-five fathoms, as the boat drifted in the current.

To Hemingway, deep drifting meant confronting the unknown, never knowing what may take the bait, and the fish never showing itself for an hour or more as the angler furiously pumps and reels, pumps and reels, trying to raise the denizen from the abyss. It may be a marlin; or it may be a broadbill swordfish; or it may be some fish that you never see at all that doggedly refuses to be budged from its lair. To drive home his point, Hemingway wrote, "In hunting you know what you are after. But who can say what you will hook sometime while drifting in a hundred and fifty fathoms in the Gulf Stream? There are probably marlin and swordfish to which the fish we have seen caught are pygmies; and every time a fish takes the bait drifting you have a feeling perhaps you are hooked to one of these" (*Hemingway on Fishing*). The prevalent theory of the day was that the biggest marlin could only be caught on a deep-set line. Cuban commercial fishermen routinely brought back big marlin, weighing five hundred pounds and more, caught by handlines that were deployed deep down.

But over time, Hemingway would shy away from drift fishing, arguing that sooner or later all marlin, regardless of their size, will spend time in the surface waters. And if they could be spotted cruising at the surface, then they most assuredly could be caught there, too, where the angler could see the rush and strike of a streaking fish. For Hemingway, the excitement of the fish's attack, albeit fleeting, was more than sufficient for him to forgo endless hours, if not a day, deep drifting on a rolling sea.

The waters off of the northern coast of Cuba are known as the Straits of Florida, a seventy-mile stretch of open water between Havana and Key West. Here the Loop Current, a robust, clockwise circulation that extends northward into the Gulf of Mexico and exits into the Straits of Florida, flows west to east. (While Hemingway in his writings would refer to this flow as the Gulf Stream, modern-day oceanographers mark

the beginning of the Gulf Stream in southern Florida.) Hemingway observed that marlin routinely traveled east to west against the current. The stronger the current flowed to the east, the more marlin he noted traveling along the edge of the current. Hemingway's keen sense of observation would over time serve him well, contributing to his success as a big-game angler.

Marlin, like humans, Hemingway noted, can exhibit different moods, which are reflected in how they strike a bait. If a marlin is hungry, it exhibits an aggressive posture: smashing the bait with its bill, thrusting its shoulders, dorsal fin, and tail completely out of the water, and spreading birdlike its large pectoral fins. If the bait is pulled out of its mouth, it will not be denied, coming back for the bait again and again. A playful marlin, one that has probably fed well, Hemingway theorized, will gently take the bait in its mouth, but upon feeling the slightest pressure from the angler, will ceremoniously drop the bait, despite the absolute freshness of the bait. The indifferent fish will swim up to the bait, look it over, shy away, come back again, piqued by its curiosity, but steadfastly refuse to hit the bait. If this fish is swimming with its pectoral fins pinned to its sides, it will not feed. The marlin is cruising, and the boat is simply on its course.

Studying the habits of fish appeared to pay off for Hemingway and his crew that season. Fishing from the middle of April through the eighteenth of July, they caught fifty-two marlin and two sailfish. The largest black marlin was 468 pounds and twelve feet and eight inches long; the largest striped marlin weighed 343 pounds and stretched to ten feet five inches; and the biggest white marlin weighed 87 pounds and reached seven feet eight inches in length. (It should be pointed out that the first two species were most likely blue marlin, which were often mistaken at that time for black and striped marlin, but both of which are found roaming the Indo-Pacific waters.)

Hemingway firmly believed that the white marlin, striped marlin, and black marlin were all sexual and age variations of the same fish. For Hemingway, the black marlin represented the last life stage of all marlin. All the black marlin Hemingway had caught were old, big, and all females. He argued that the life cycle of marlin is similar to jewfish (now known as goliath grouper): becomes a female at the end of its life span, regardless of how it starts. But the blue marlin to Hemingway was

an oddity, a fish that he couldn't classify as to its origin. He questioned whether these marlin are color variations of the white marlin, whether they are both male and female, and whether they are separate species.

For Hemingway, fishing was a vital component in the mythos he forged for himself, holding a special place in his turbulent life. If he was to be true to the sport, he needed to resolve the thorny issue of marlin speciation, or at least look at it through an unvarnished lens.

By 1934, Hemingway had purchased a new boat, the *Pilar*, which he named after a shrine in Spain that commemorates Nuestra Señora del Pilar, our Lady of the Pillar. For the next twenty-seven years, Hemingway would fish the *Pilar* from the waters around Cuba to the Florida Keys to the Bahamas. As Paul Hendrickson writes in his book, *Hemingway's Boat*, the *Pilar* was a reflection of her owner: "a functional fishing machine, sturdy, reliant, built to take the heaviest weather." Though the *Pilar* was a "stock boat" of the 1930s, Hemingway would, over the decades, tinker with her, adding modifications and innovations that would ultimately be adopted by the vessels of today.

But in his first year of ownership, Hemingway not only continued to fish with Gutierrez but also invited aboard the *Pilar* two scientists: Charles Cadwalader, director of the Philadelphia Academy of Natural Science, and Henry Fowler, who was the academy's chief ichthyologist. These two men were in Cuba to catch and examine marlin in order to sort out the taxonomy of marlin species, trying to figure out if the white, blue, black, and striped marlin were different species. After an arduous month of collecting a representative sample of marlin, Cadwalader and Fowler had enough data to reclassify all the marlin species for the North Atlantic. The revised taxonomy would list the white and blue marlin as separate and distinct species.

Hemingway would continue to pursue big marlin in Cuban waters well into the 1940s. Fishing assumed a position of primacy for Hemingway, going beyond a mere sport but becoming an important exercise that defined Hemingway's philosophy and style of life.

A friend, who was enamored with the danger of elephant hunting, once queried Hemingway about where the thrill is in catching a marlin on rod and reel. Where is the excitement in fishing for them from a boat, as opposed to being in their element as you would be in facing

head on a charging elephant? To Hemingway, the answer, which he ultimately includes in his deliberations on angling, *Hemingway on Fishing*, reflects his pugnacious nature, always ready for a good fight, but in the same vein respecting his adversary:

> It comes from the fact that they are strange and wild things of unbelievable speed and power and a beauty, in the water and leaping, that is indescribable, which you would never see if you did not fish for them, and to which you are suddenly harnessed so that you feel their speed, their force and their savage power as intimately as if you were riding a bucking horse. For half an hour, an hour, or five hours, you are fastened to the fish as much as he is fastened to you and you tame him and break him the way a wild horse is broken and finally lead him to the boat.

In a 1936 article for *Esquire* magazine, titled "On the Blue Water: A Gulf Stream Letter," Hemingway was at his best in deciphering the mysteries of big-game fishing to the uninitiated. To convey to the reader the wonders of the sea and its creatures, Hemingway tells the story of an old Cuban fisherman, who, while fishing alone, catches a great marlin, using only a baited handline. For two agonizing days and nights, the fisherman relentlessly fights the fish, finally bringing the marlin close enough to harpoon. Realizing that the fish is too big to pull into his small boat, the old man lashes it alongside, where it is attacked by sharks. The fisherman strikes back against the sharks—clubbing them, stabbing at them, and even lunging at them with an oar until he is too exhausted to continue the fight. The defeated man sees his prized catch decimated by the sharks.

Sound familiar? This tale was the literary seed that would grow to become Hemingway's critically acclaimed *The Old Man and the Sea* some sixteen years later. In February 1939, Hemingway informed his editor, Maxwell Perkins, that he was finally working on "the old man story," and he, accompanied by Gutierrez, would soon be heading out to sea in a skiff to ensure that all the details were correct. But one question that seems to stand out is, why did Hemingway procrastinate in writing his prize-winning novella? He had already outlined the basic plot in the *Esquire* magazine article. Maybe some insight can be gained from a 1935 letter Hemingway wrote in which he describes writing as

"something that you can never do as well as it can be done. It is a perpetual challenge and it is more difficult than anything else I have ever done—so I do it."

Billfish: A Sportsman's Quest

During the latter part of the 1930s, when Hemingway's fishing exploits were becoming legendary, there was no universal set of rules governing anglers in their pursuit of their quarry. While some venerable fishing clubs, like the Tuna Club of Avalon and the Long Key Fishing Club, had some rules in effect pertaining to angling conduct, these rules varied according to the bylaws of each club.

The idea of a global alliance of anglers committed to the advancement of sportsmanship and fair angling practices had been simmering for some time in England, Australia, and the United States. But the impending threat of war and the lack of strong leadership stalled any momentum the movement may have had.

A leader would emerge from a most unlikely candidate—a man who valued his privacy and his personal life above all else. Michael Lerner began his fishing odyssey with his father on afternoon fishing outings on Sheepshead Bay in New York, where they caught flounder and porgy. But he would experience a kind of angling epiphany when he caught his first swordfish—the single game fish that he held above all others. While he admired the swordfish's power and size, he pondered its elusiveness and reclusiveness. How far down does it swim? Where are its primary spawning sites? What currents does it ride to its feeding grounds? Lerner would soon become driven to decipher the mysteries of this species, assuming the role of an angler-naturalist.

Lerner's admiration for the swordfish had its roots in his keen interest in all billfish. On one occasion in 1935, he walked into the American Museum of Natural History in New York City, declaring to a befuddled guard that he wanted to donate a mounted specimen of a large blue marlin that he caught. After much searching around, Lerner was introduced to Francesca LaMonte, Associate Curator of Fishes, who was quite pleased to receive the gift and would ultimately find a home for it in the Hall of Fishes of the World. But Lerner's initial encounter with the curators and naturalists of the museum would be the start of

his long-term association with the museum's staff to gather as much data as possible about billfish.

In 1939, Lerner financed a fishing expedition to the waters of Australia and New Zealand in conjunction with personnel from the museum. While abroad, he discussed with Clive Firth, one of Australia's premier anglers, the idea of forming an international governing body composed of anglers worldwide. Firth was enthusiastically receptive of Lerner's proposal and went as far as to suggest that the organization be American based. Lerner agreed and underwrote the expense for the establishment of this international body, which became known as the International Game Fish Association—a fraternity of anglers committed to the highest standards of sportsmanship and ethical angling.

William Gregory, who was one of the museum's representatives on this expedition and head of its Departments of Ichthyology and Comparative Anatomy, proposed that this embryonic organization also be affiliated with the museum, thereby facilitating an exchange of ideas, information, and data between anglers and the museum's scientific personnel. On June 7, 1939, the International Game Fish Association (IGFA) was formally launched in a meeting held at the American Museum of Natural History, and Gregory was elected its first president.

Over the years, the IGFA has grown not only in membership but also in its scope and objectives. In addition to being an umbrella organization for anglers around the globe, the goals of the IGFA are "to encourage the study of game fishes for the sake of whatever pleasure, information, or benefit it may provide; to keep the sport of game fishing ethical; to make its rules acceptable to the majority of anglers, and to encourage this sport both as recreation and as a potential source of scientific data." The IGFA also serves as a storehouse of world-record catches, collecting and publishing world record data for scores of species as well as studiously reviewing applications for potential world-record catches. Hemingway, who would become one of IGFA's officers, was of the opinion that many billfish catches did not adhere to IGFA standards, since the angler was unfairly aided by another angler or mate. (According to IGFA's angling procedures found in "IGFA International Angling Rules," the following action will disqualify a catch: "The act of persons other than the angler in touching any part of the rod, reel, or line

either bodily or with any device, from the time a fish strikes or takes the bait or lure, until the fish is either landed or released.")

Fishing Legends

Many angling historians consider the 1930s as the golden age of big-game fishing. In addition to Lerner and Hemingway, S. Kip Farrington and Tommy Gifford were routinely catching record-setting billfish during this period. And they all had one thing in common—the island of Bimini.

Bimini is the far western island in a chain of islands officially known as the Commonwealth of the Bahamas. Prior to its permanent settlement in 1840, the island had been the haunt of pirates, including Francis Drake and Henry Morgan, during the seventeenth and eighteenth centuries. Its location on the edge of the Gulf Stream made it the ideal site to engage the Spanish treasure fleets on their return trip to Spain. But by the 1930s a cadre of hard-core anglers was engaging the huge blue marlin that routinely rode the Gulf Stream northward.

On February 28, 1933, S. Kip Farrington landed Bimini's first recorded blue marlin. News of Farrington's catch spread fast, and within two months of his feat, Ann Moore, a New Yorker, landed a five-hundred-pound blue marlin off of Bimini. By 1935, after the devastation of the Long Key Fishing Club in Florida, anglers looked to Bimini as the new, fertile fishing ground.

As saltwater editor of *Field and Stream* magazine, Farrington continued to popularize Bimini, and soon Michael Lerner and his wife, Helen, who was an accomplished big-game angler in her own right, arrived on Bimini and soon found it an amazing place for fishing, routinely catching limits of marlin and swordfish. So enamored was Lerner with Bimini, he built a magnificent home on the island and would ultimately establish a marine laboratory there to promote his interest and love of the sea.

Tommy Gifford was a Florida-based guide, who though he would often disparage the fishing abilities of his own clients and often claim credit for their catch, would still distinguish himself as a first-rate angler over a forty-year career. He had his own theories about fishing, and from these, he would not budge. One of them was that trolling was not the

best method to catch sailfish; more can be caught by using live bait while drifting or anchoring along the edge of the coral reefs that border the Gulf Stream. When his charter would question this tactic, Gifford would bark out "go to hell; if you want to catch fish, listen to me."

And catch fish he did, setting numerous world records. But an inscription in one of Hemingway's books probably best sums up Gifford's angling prowess: "To Tommy Gifford who was catching them off Cuba when we first began. Who kept on catching them, bigger and bigger. From his friend and admirer, Ernest Hemingway."

Over his fifty-year career, Gifford not only developed an encyclopedic knowledge of fishing but also earned the reputation as a master innovator, routinely modifying his tackle to fit his needs. While in Bimini, Michael Lerner, with Gifford as his guide, caught a 478-pound blue marlin. The catch was aided by an invention of Gifford—the outrigger. These long poles, which are now standard equipment on today's offshore boats, swing out from each side of the boat and allow for the deployment of the fishing line without the angler holding the rod and reel. Gifford's original outriggers were made from a combination of bamboo and Japanese cane poles fitted together to make poles fifty feet long. After some sea tests and subsequent modifications, these outriggers were instrumental in catching the first giant blue marlin in the Atlantic.

In 1935, when he was thirty-six years old, Hemingway found his way to Bimini, having heard the stories of the giant billfish that roam its waters. During his stay on the island, his fishing exploits would find their way into his writings. His novel *Islands in the Stream* (1970), published nine years after his death, describes in rich detail the adventures and emotions of a young angler fighting his first swordfish off the island of Bimini. To recognize his contributions, both as an angler and as an author of vivid fishing stories, Hemingway was inducted into Bimini's Fishing Hall of Fame in 1993.

Spreading the Billfish Gospel

Big-game angling in its early years was commonly viewed as a rich man's sport and with some justification. Many of its major participants were finically well off. Zane Grey was able to underwrite his extensive fishing

expeditions through the publication of his numerous western novels. He may have been the first American writer to have over a million copies of his books sold. Michael Lerner was a businessman who together with his brother founded the Lerner Shops. These upscale dress shops provided Lerner with a considerable amount of income.

But a sea change in big-game fishing was coming. In 1937, Ernal Foster, a fisherman and resident of Hatteras Island in North Carolina, built his first boat, the *Albatross*, which he intended to use for both commercial and recreational fishing. He would fish the winter months with his fellow watermen and pursue big fish the rest of the year. During his first year of chartering, he made only four offshore trips, at a price of $25 dollars per charter.

Over the years, Foster's clientele would expand, as he became widely known as the captain who could "find the fish." And yet many of Foster's anglers didn't want to tangle with the blue marlin, preferring to leave the blue beast alone. Even the Hatteras old timers, as Tom Carlson writes in his book *Hatteras Blues* (2005) "didn't want to fool with these things—too big, too scary." But Foster was determined to catch a blue marlin, many of which he had seen on his charters to the Gulf Stream. In 1951, he hooked a blue marlin and politely offered the rod to the members of his fishing party, who unanimously turned him down. Undeterred, Foster, without the aid of a fighting belt or harness, subdued the great fish after a two-hour battle. While he wasn't the first angler to catch a blue marlin in North Carolina waters—that honor goes to the New Jersey angler Hugh Rutherford aboard a private boat in 1939—Foster's catch was the first from a recreational vessel. His catch would also mark the beginning of a mass influx of anglers, representing all societal levels, all intent on catching a blue marlin. In 1962, a world record blue marlin, weighing 810 pounds, was caught and prompted one reporter to dub Hatteras Village "the blue marlin capital of the world." While that record has since been broken, that moniker still lingers in the hearts and minds of many residents and visitors to this windswept stretch of the North Carolina coast.

4 Anatomy of Tournaments

For over two hours, angler Andy Thomasson aboard the *Citation* had struggled with a blue marlin that refused to surface, opting instead to bulldoggedly hunker down, but Thomasson's determined efforts ultimately brought the marlin to the gaff. As Captain Eric Holmes related, "When we finally saw it, we couldn't believe it." And back at the dock, the monster-sized fish tipped the scale at 883 pounds, a new record for the annual Big Rock Blue Marlin Tournament. The crew aboard the *Citation* was ecstatic; that marlin earned them over $1 million in prize money during the 2010 tournament.

But that dream fish proved fleeting; three days later, the tournament directors unanimously agreed to disqualify *Citation*'s catch. Had the angler or the crew violated a rule of the International Game Fish Association, the overseeing angling organization that sets the rules for ethical angling and sportsmanship, which most tournaments adhere to? The big marlin had been tail wrapped—the fish became entangled in the fishing line, but that unfortunate event, which probably prevented the marlin from surfacing, did not disqualify the catch.

The culprit? A North Carolina fishing license, or more precisely the lack of one. Peter Wann of Alexandria, a mate aboard the *Citation*, did not have in his possession the requisite license when the marlin was caught. (The tournament rules explicitly state that "the North Carolina Division of Marine Fisheries will require a recreational fishing license for anyone participating in fishing aboard a vessel.") He had purchased a license online at 5:51 p.m. while on his way to the weigh station, but the fish was boated at 3:15 p.m. A thirty-dollar mistake—the cost

of a nonresident fishing license—ballooned into a very expensive lesson in tournament fishing. As Thomasson ruefully said, "We didn't do anything wrong. But one of our people did. He failed to get a fishing license, but we didn't know it. He told us he had it. He didn't. They're taking it away, everything. The fish is disqualified. We're disqualified. That's the end of it."

Tournament Fever

The first billfish tournament on record in the United States was initiated and sponsored by Zane Grey in the Florida Keys. While not strictly limited to billfish—awards were also given for the largest bonefish and king mackerel—the tournament would specially recognize the longest sailfish caught during the fishing season (December 14 to April 15) on nine-thread (twenty-seven-pound test) line. Zane's brother, R.C., also donated a rod for the largest sailfish caught over sixty pounds on a six-ounce tip and twelve-thread (thirty-six-pound test) line. Buttons were awarded for various catches: bronze for sailfish over forty pounds, silver over fifty-five pounds, and gold over sixty-five pounds. The idea of awarding buttons stems from Grey's days at the Tuna Club, which routinely offered ornate buttons for outstanding catches. A yellow button, for example, with an emblem of a swordfish on it was given to that angler who caught the fish on light linen line, and a gold button was for a swordfish caught on heavy line.

The act of going head to head with other anglers in a formalized tournament setting to determine who could catch the biggest fish would spread rapidly since Grey's early foray into competitive fishing.

On May 26, 1950, thirty-six boats motored out of Havana harbor in search of big marlin. One of those boats was the *Pilar*, owned by Ernest Hemingway, who participated in this first tournament, representing the International Yacht Club de La Habana. A group of anglers put forth the proposal of naming the tournament after Hemingway, in acknowledgment of his big-game angling accomplishments and sportsmanship. Hemingway not only agreed but also won the cup for the first three tournaments.

During the early 1960s, the tournament was suspended due to tensions between the United States and Cuba, culminating in the Bay of

Pigs invasion. In 1963, the tournament resumed, but only on a national basis, and was run that way until 1977. In 1978, the tournament directors changed their policy, allowing for international participants to enter. Today, the Ernest Hemingway International Billfish Tournament is still going strong, making it one of the granddaddys of big-game saltwater tournaments in the world.

The honor for the oldest continuous blue marlin tournament in the world goes to the International Billfish Tournament of Club Nautico de San Juan, with more than fifty-nine annual contests. With an abundance of blue marlin in the surrounding waters, the tournament was the first to break the 100-catch mark during the 1983 event and topped that number in 1987, when anglers caught 137 blue marlin.

In the beginning, most billfish tournaments sprouted up in close proximity to billfish haunts, which generally meant near the warm, blue water of the Gulf Stream. From Florida and Caribbean marinas, it was only a short run to the fishing grounds. But for anglers departing from mid-Atlantic ports, it could mean a one-way trip of sixty, eighty, or even one hundred miles to reach the Gulf Stream.

The vintage boats of the pre–World War II era were simply too small and too underpowered to make the long run to the offshore waters. By the late 1940s and early 1950s, the boats and engines increased dramatically in size—horsepower skyrocketed and fuel capacity increased. Size really did matter.

In the summer of 1959, three boats, hailing from different New Jersey ports, would be the first to reach and fish the far offshore waters, opening up a whole new venue for other anglers. One interesting character was Fin Magnus, who by profession was in the piano and organ business. But he was an avid angler. As owner of the *Magnus*, which was docked in Brielle, New Jersey, he made frequent trips up and down the mid-Atlantic coast, from New York to Maryland to Delaware, in search of blue water. His boat, a round-bottom forty-eight-footer, was rigged not only for billfishing but also with an organ that Magnus religiously played on his offshore excursions.

By the late 1960s, offshore fishing really took off, with the availability of improved fishing tackle and advanced boat technology. With regard to the latter, diesel engines became readily available for both recreational and commercial fishing vessels. These reliable, high-powered

engines would shorten the time to reach the productive fishing grounds.

These early forays out into the Atlantic would spawn one of the most successful billfish tournaments on the eastern seaboard—the Mid-Atlantic $500,000, held each year in Cape May, New Jersey. The 2010 tournament, in particular, proved to be an epic event, with 134 boats catching 537 white marlin and 13 blue marlin. But the action is not confined to the water. Hordes of spectators gather each tournament day for the weigh-in at the docks, as well as follow all the proceedings online with live video links and chat room exchanges.

Down in Maryland, boats didn't make the long offshore trip until the 1960s. But once there, their owners and anglers would put up impressive numbers of white marlin catches, ultimately garnering the recognition for their home port, Ocean City, as the white marlin capital of the world. This moniker appears more applicable than ever as Ocean City hosts the prestigious White Marlin Open, which in 2005 set a record as the largest marlin tournament ever held, with 449 boats participating.

Early billfish tournaments were primarily "kill" tournaments—the caught fish was gaffed, boated, and brought back dead to the dock. If the fish was to be considered for an award, it had to be officially weighed to determine its size. So billfish after billfish, both small and large, were hung by their tail at the weigh station. Anglers were duly proud of their catches and more than willing to pose beside their fish, with rod and reel in hand, for a few photographs, before the fish was unceremoniously dumped back into the water. And, of course, the slayers of these beasts would also soak up the praises of the awe-inspired onlookers. The hunters had returned victorious after great battles, and rounds of congratulatory drinks were in order.

Some historians have speculated that this act of killing another species that will not be consumed is rooted in early Western philosophical tradition that denies any moral relationship exists between humans and nature. The main tenet of this condition is that only human beings have moral standing; all other things have value only in that they serve human interests and needs. The two philosophers most associated with this belief, Aristotle and Thomas Aquinas, proposed views that demonstrated little interest in assigning moral status to forms of life other than humans. Aristotle espouses the following

in his work *Politics*: "All other animals exist for the sake of man, for use he can make of them." Sixteen centuries later, Thomas Aquinas picks up this theme but expresses it in a more theological context: "We refute the error of those who claim that it is a sin for man to kill brute animals. For animals are ordered to man in the natural course of things, according to divine providence. Consequently, man uses them without any injustice, either killing them or employing them in any other way."

On the flip side of the coin, many religious zealots among the American colonists viewed angling as a sinful pursuit. They questioned angling on the moral ground that it inflicted undue pain on one of God's creatures. Cotton Mather, an influential New England Puritan minister, went as far as chastising his fellow clerics for idling away their time angling.

Even Hemingway, who probably did more to popularize the lure of billfishing, expresses a slightly different view in his writings about killing billfish. Santiago, the protagonist in Hemingway's novella *The Old Man and the Sea*, initially becomes obsessed with the idea of proving himself a worthy slayer of such a grand fish. But soon after subduing the fish and tying it to his skiff, he reflects whether his killing of the huge marlin was a sin. Santiago rationalizes that he had killed the marlin for food, and if this is a sin, then everything else is a sin. But he admittedly acknowledges that he killed the marlin not only to feed himself and others, but "you killed him for pride and because you are a fisherman. You loved him when he was alive and you loved him after. If you love him it is not a sin to kill him."

In August 1958, an unusual event occurred that generated a groundswell of opinions on the killing of billfish. Jack and Ellie Cleveland of Greenwich, Connecticut, had chartered Ernal Foster's boat, *Albatross II*, for a day of blue marlin fishing in the Gulf Stream, which brushes up against North Carolina's narrow continental shelf on its rush northward. Jack Cleveland, under Foster's patient tutelage and guidance, ultimately caught a blue marlin. While naturally pleased with achieving his angling goal, Cleveland was insistent that his marlin be released instead of brought back to the dock, which was the norm for anglers along the Outer Banks. Foster, recognizing that Cleveland was unwavering in his decision, sent the marlin back to the sea. This simple

act marked the first deliberate release of a blue marlin, leaving the residents of Hatteras Village dumbfounded upon hearing the news. "People thought they were crazy," said Ernie Foster, son of Ernal Foster. "There was a lot of ridicule and snide comments." Cleveland's deed didn't change peoples' minds about fishing practices, but it got people talking all along the eastern seaboard.

Though Michigan fly anglers instituted catch-and-release fishing during the 1950s as a means of reducing the practice and expense of trout stream stocking, it was slow to gain acceptance in the saltwater angling community. The practice butted up against the widely held belief that the oceans had an unlimited bounty of life; it would be impossible to deplete these resources.

The following decades would herald in a change in the way humans viewed the oceans' resources, as fish populations were drastically reduced due to the demand for relatively cheap protein and improved fishing gear that could "strip mine" the sea clean. From cod to haddock to tuna, no species was left untouched. A fishery that was once viewed as infinite was now correctly perceived as finite; sustainability became the rallying word.

Even as far back as 1920, a distraught Zane Grey expressed in *Tales of Swordfish and Tuna* his dismay with the actions of some boatmen and anglers: "Is sportsmanship and conservation gaining in this country? No! The good old U.S. is going the way of crass materialism. Will there be any fish for our great-grandchildren? No! Not unless so-called sportsmen band together for conservation."

Further along this sea change, one of the components of the environmental movement that swept through the country in the late 1960s was the role of ethics in our relations with the natural world. By the 1990s, this concept would broaden into biocentric ethics. It supports the view that all life possesses an intrinsic value—valuable in itself and not simply for its use. Though the roots of biocentric ethics are ancient, a pillar within the teachings of Buddhism and Jainism, Joseph DesJardins, a noted modern-day proponent of the idea, argued that to view living organisms as having an inherent worth is to embrace the attitude of respect for nature.

Hemingway may have touched on this concept. Santiago, upon realizing the great marlin could easily destroy his tiny skiff if it wanted to,

offers up the plea, "Thank God they are not as intelligent as we who kill them, although they are more noble and able."

Big-game anglers, scientists, and tournament directors came to the consensus that changes had to be made in billfish tournaments, with the biggest one being that awards be given for the release of billfish. Two early advocates for the release of billfish in the name of conservation were Eric Prince, a billfish biologist at the Southeast Fisheries Science Center in Miami, and Tim Choate, who was one of the first anglers to catch and release more than one thousand billfish in one year.

Resistance to change still popped up in some quarters. Some anglers opined that an exhausted billfish after a prolonged fight would not survive the ordeal or would be easy prey for sharks, such as was the fate of Santiago's prized marlin. Even Tim Choate noted that a number of his released fish seemed lethargic, swimming a bit too slowly. There was some merit to the naysayers' argument: if the fish was going to die anyway, why not just keep it?

The degree of fight in a fish depends on the nature and functioning of its muscles, which, in turn, depend on an energy source and oxygen. Both of these are transported to the muscles as a result of a fish's circulatory system. But there are physiological limitations with regard to how much energy and oxygen the heart and blood can transport to the muscles. As the fish struggles to regain its freedom, the oxygen in the muscles becomes depleted, the energy supply is exhausted, and metabolic wastes, particularly lactic acid, accumulate in the muscles. If the fish is unable to eliminate the lactic acid, extreme muscle fatigue can result, and ultimately the fish could succumb to its weakened state.

A key variable in the above scenario is the amount of dissolved oxygen that the fish is able to extract from the water. The amount of dissolved oxygen in the water decreases with water temperature. In warm water, such as the Gulf Stream, the lactic acid accumulates quickly in the muscle tissues, and the fish tires much more rapidly.

Anglers would soon learn that the chances of survival of a billfish would depend on their actions. What they did in particular situations would mean the difference between a healthy fish strongly swimming away or one that struggles, ultimately succumbing to the stress of the encounter.

The thrill that a hooked fish provides to the angler can be quite intoxicating, as the fish may jump, make sustained runs, and hunker down in the current in its attempt to escape. But crucial to the survival of the fish is how quickly the fish is fought and landed. Essentially, a short fight and a quick release increased the chances of survival of the fish. Even as far back as 1931, Hemingway addressed this issue of billfish survivability: "We try to fight them fast, but never rough. The secret is for the angler never to rest. Any time he rests the fish is resting. This gives the fish a chance to get strong again, or to get down to a greater depth, and the odds lengthen that something may close in on him."

A skilled angler, possessing the techniques to outwit a billfish and assisted by a competent crew, can land a big billfish in relatively short order. Angler Deborah Dunaway, who at one time held the world records for all nine billfish species, fought her 381-pound black marlin on sixteen-pound line for just under ten hours. But each fish reacts differently. A year later, Elizabeth Hogan subdued her 445-pound black marlin in about forty-five minutes.

A lethargic billfish or one that exhibits erratic behavior is not a good candidate for immediate release. The fish may require some additional help before it can swim away. After the hook has been removed, the mate may revive a moderately exhausted fish by grabbing it by its bill as the captain slowly motors forward to force oxygen-enriched water over its gills. At the first sign of revival, the fish can be released.

At times, small billfish, such as white marlin and sailfish, are removed from the water prior to their release. With prolonged exposure to air, such as occurs during photo opportunities of the catch, the billfish's gills collapse, with the individual filaments adhering to each other, which can lead to a rapid decline in blood oxygen levels, tissue damage, and eventually death.

Even billfish that have been out of their element only for a short period of time may experience undue stress if not handled properly. The fish should be supported horizontally. A billfish held for a prolonged period in the vertical position can experience damage to its internal organs.

While many of the above practices were widely adopted by the angling community, grumblings could still be heard that not all released billfish

were surviving. The problem was the nature of tackle, particularly the hook, employed to catch the fish, and this tackle can be traced back centuries.

As pointed out by R. W. Dunfield in *The Atlantic Salmon in the History of North America* (1985), the word *angle*, in its original meaning, did not imply the use of a rod but meant simply to fish with a hook or angle. Egyptian paintings were the first to show how to fish with a rod, a line tied directly to the tip of the rod, and a barbless hook, which had a shape similar to today's hooks—J shaped. The next evolutionary step occurred around 200 B.C., when the Chinese began using metal hooks with barbs.

A J hook works by penetrating the fish's mouth tissue and attaching firmly to the flesh via a barb. Due to a billfish's bony mouth, the J hook may not be able to obtain purchase, sliding down into the throat, esophagus, or stomach. A deep-hooked fish may suffer internal injuries, such as bleeding or organ damage, which can be fatal. Removing the hook may not be an option since the process of extracting a hook that is embedded deep within the fish may exacerbate the problem. The only alternative if the fish is not to be killed is to cut the leader, leaving the hook inside the fish's body. Even this tactic may prove futile since the fish may ultimately succumb to an infection or to an inability to feed.

Here is where the use of circle hooks has played a vital role in billfish conservation. At first glance, it would appear that the design of these hooks would severely limit even the hooking of a fish. They are manufactured so that the hook's point is turned perpendicularly back to the shank of the hook to form a generally circular or oval shape, resulting in a small opening between the point and the shank.

Detailed studies, however, have tested the effectiveness of circle hooks on billfish. One study conducted by the fisheries branch of the National Oceanic and Atmospheric Administration (NOAA) in the spring and summer of 1999 evaluated the performance of circle and J hooks on Atlantic and Pacific sailfish. Careful analysis of the data showed that circle hooks proved to be as effective as, or even more effective than, J hooks for catching sailfish. Specifically, almost twice the number of sailfish were hooked on circle hooks than on J hooks. On another positive

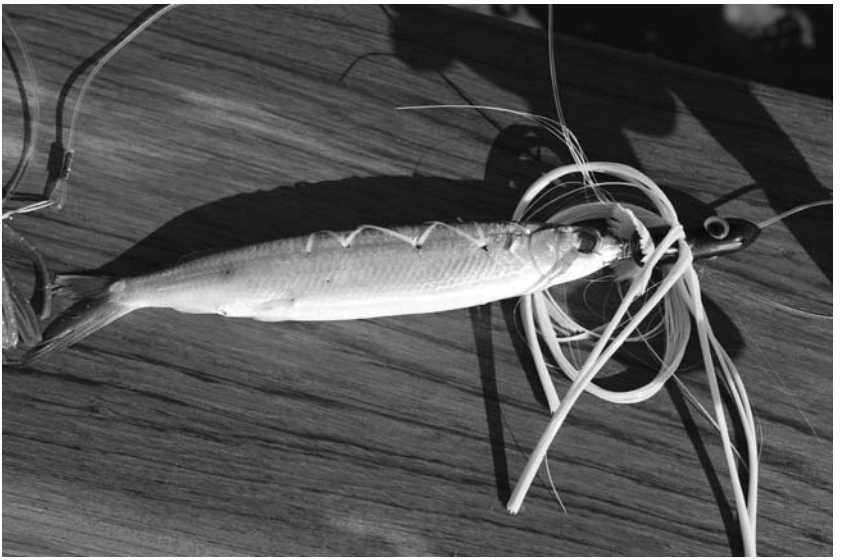


PHOTO 5. Rigged baitfish. Courtesy of Tom McMurray.

note, 85 percent of the sailfish were hooked in the corner of the mouth using circle hooks, whereas only 27 percent were hooked using J hooks; the latter's lower percentage reflected more deep-hooked sailfish.

While the results may have surprised many old-time anglers, long-line commercial fishing boats have used circle hooks since the 1970s. And with good reason. Not only was the hookup ratio higher, but also the total catch was considerably higher than with the previously used J hooks.

Circle hooks prevent internal injuries, in part, because the fish hooks itself. As the fish swims away with the bait in its mouth, the line becomes taut, allowing the hook to rotate inside the fish's mouth and lodge itself in the corner of the mouth. In addition, anglers can remove the hook easily, facilitating a quick release, by grabbing the hook firmly with a pair of pliers and rotating the hook out of the fish's mouth.

But the question remains: do released fish, even those fought quickly and with the proper tackle, survive? The answer eluded researchers because there was no way to track and monitor the fish upon release. In the 1990s sophisticated tagging technology allowed researchers for

the first time to follow billfish for extended periods of time. In 1999, Eric Prince, Brian Lucklurst, and John Graves attached a state-of-the-art monitoring device each to nine blue marlin, which were caught off of Bermuda. The data retrieved indicated that the marlin had indeed survived upon being released—affirming the conservation benefit.

Buoyed by these findings, Graves and graduate student Andrij Horodysky investigated the survivability of white marlin that were caught on baits rigged with J hooks versus circle hooks. The results would open the eyes of many doubters on the effectiveness of circle hooks in drastically reducing billfish mortality. Graves reported in *Marlin* magazine that "seven of twenty white marlin caught on J hooks died within ten days of release, while none of the twenty white marlin caught on circle hooks died."

In a follow-up study, Graves and his colleagues looked at the efficacy of circle hooks over a wider spectrum of billfish, including blue marlin, white marlin, and sailfish. For all three species, there was a positive result of using circle hooks compared to J hooks, but the magnitude of the benefit varied among the billfish, with blue marlin experiencing the smallest incremental change.

The National Marine Fisheries Service (NMFS), a division of the Department of Commerce responsible for the stewardship on the nation's living marine resources and their habitat, was quick to pick up on these studies. Starting in 2007, the NMFS mandated that all billfish tournament participants in the Atlantic, Gulf of Mexico, and Caribbean who use natural bait or natural bait and artificial lure combinations will be limited to using only circle hooks.

The aforementioned Big Rock Blue Marlin Tournament, a big-time event with over fifty years of history, was probably ahead of the pack in billfish conservation. Beginning with the 2003 tournament, its directors agreed to award additional release points for those billfish caught on circle hooks in lieu of J hooks.

While the White Marlin Open Tournament still requires fish to be brought in and weighed at the official scale at Harbour Island Marina in Ocean City, Maryland, for consideration for prizes, tournament directors have enthusiastically encouraged the release of billfish by awarding noncash prizes for the most release points accumulated by an angler.

PHOTO 6. Bait preparation. Courtesy of Tom McMurray.

The majority of the scientific community believes that billfish tournaments do not pose a serious threat to the billfish population. The vast majority of the billfish that are caught are released, and most of these survive due to the use of mandated circle hooks. In the 2008 White Marlin Open, anglers caught 349 white marlin but killed only 16 of them (about 5 percent of the total). For blue marlin, 23 were reeled in and 3 killed (13 percent). Eric Prince, who has studied billfish populations worldwide for decades, relates that on an Atlantic-basin scale the loss of tournament-killed billfish from the overall population size is relatively small. (The NMFS presently limits the number of billfish that can be killed annually in all tournaments to 250.)

While the nature of tournaments has changed from all kill to a combination of release and kill or all release, the greatest evolutionary leap may be in the nature of prizes awarded. Prior to the 1970s, most billfish

tournaments were trophy only events, competitions among sportsmen vying for bragging rights and occasionally willing to engage in a friendly wager.

In 1973, Jim Motsko, a then twenty-something college student who had mated on Ocean City charter boats, launched the White Marlin Open, which would guarantee cash prizes for every winner. That year, fifty-seven boats entered the tournament, and the first place white marlin was worth five thousand dollars. But Motsko was not content to see the culture of side bets, known as Calcuttas, continue to proliferate without any oversight. So he ultimately decided that the tournament itself would collect the money, keep track of all the betting pools, and distribute the winnings at the end. An angler could now pay the base entry fee and pony up additional money for "added entry skill levels," each with their own payouts. Motsko has maintained that these "tournament Calcuttas" are legal since anglers are paying additional entrance fees to fish within individual categories of the tournament (for example second biggest white marlin, third biggest blue marlin). The attorney general's office of Maryland has studied the issue and concluded that the tournament's rules do not appear to violate any of Maryland's gambling laws and are thus legal.

The 2011 tournament had 250 boats in it, and the total prize money was about $2 million. While the basic entry fee of $1,000 guaranteed the winner $50,000, the real money to be made was in the side bets. The largest white marlin caught that year was 88.5 pounds and earned the crew $289,063. But the second largest white marlin (86.5 pounds) was worth a whopping $758,829 due to additional wagering.

Many of the billfish tournaments that are staged annually throughout the Atlantic basin have followed the lead of the White Marlin Open, offering large payouts. The Mid-Atlantic $500,000 claims—boat for boat—to be the richest marlin tournament in the world, offering a top prize of $100,000 for the heaviest white marlin. And with the possibility of a huge financial windfall jumping into their laps, anglers may be tempted to cheat—knowingly violate a tournament rule, alter a fish's weight, or present a fish not caught on designated tournament days. To deter anglers from cheating, big-money tournaments require top winners and others deemed necessary by officials to submit to a polygraph

PHOTO 7. Tournament boats at dock, flying marlin flags. Courtesy of Tom McMurray.

test. Those participants who refuse to take the test or fail to answer the questions in a manner deemed satisfactory by tournament officials may be disqualified. By entering the tournament, participants also consent to the admissibility of the test results in any future disputes arising out of the tournament.

In the case of the *Citation* discussed at the beginning of this chapter, captain Eric Holmes told officials that his mate had not produced proof that he had a valid North Carolina fishing license. Tournament officials responded by requiring the mate to submit to a polygraph examination, which he subsequently flunked.

Almost a year after the tournament directors' decision, a judge from Carteret County, North Carolina, dismissed a lawsuit brought by the owners of *Citation* that had challenged the disqualification. He declared that the boat was "in violation of tournament rules, and thus was properly disqualified." As of this writing, a lawyer for the *Citation* group has appealed the decision. No prize money has been distributed as of yet.

Fishing the Big Rock

In mid-June 2011 I traveled southward on the thin, sandy strands of land known as the Outer Banks of North Carolina toward a fishing expedition. Off to the east, distant cumulus clouds bubbled upward into the thin atmosphere, fueled and nourished by the heat from the underlying Gulf Stream—my destination in the next day or so.

At Oden's Dock in Hatteras Village, I met up with Dale Britt, captain of the charter boat *Sensation* and one of the participants in the 2011 version of the Big Rock Blue Marlin Tournament. The tournament derives its name from a structure on the edge of North Carolina's continental shelf known as the "Big Rock." The Big Rock—which is not a rock at all—is a compilation of plateaus, peaks, and ledges covering approximately nine square miles of ocean floor. Observations and catches over the years have shown that blue marlin are attracted to this area because it is rich in small fish that seek shelter.

Though Britt is based in Morehead City, where the tournament headquarters are located, he decided beforehand to fish the waters to the north of Big Rock and take advantage of the short run to the Gulf Stream through Hatteras Inlet. Britt's plan, as he related to me, was to fish the western edge of the Gulf Stream, seeking out thermal breaks and color changes that concentrate prey for billfish. Britt holds over twenty-five years of experience as a charter boat captain and tournament angler to the Big Rock and like most successful anglers possesses innate perceptual-cognitive skills—he is able to critically observe the environment, think about temporal and spatial relations, and arrive at a rational conclusion as to what is "fishy" water. He had mulled over the idea of making the trip to the eastern side of the Gulf Stream, which some tournament boats would do, but though there would be fewer competing boats there, the idea of crossing over more than sixty miles of open, blue water just didn't seem appealing. Britt developed his strategy and stuck with it; a "run and gun" approach (traveling quickly from one site to the next to fish) is simply not feasible when time on the water is at a premium.

More than 130 boats fished in the 2011 tournament, with boats coming from as far north as Massachusetts and as far south as Florida. The boats were permitted to leave from designated marinas along the North

Carolina coast, but all billfish eligible for prize money were required to be off-loaded at the official tournament weigh station in Morehead City. A qualifying blue marlin, weighing at least 400 pounds or measuring at least 110 inches, would necessitate a three-hour trip to the scales—a long boat ride, but one well worth it.

The tournament directors scheduled six available fishing days, but boats were allowed to fish only on four of those days. The captains were granted flexibility to choose which four days to fish, but they were required to notify tournament officials in advance which days would be nonfishing days. Britt and his crew opted for a marathon outing, fishing the first four tournament days.

The morning of a fishing day is not only one of anticipation and bantering about who caught what and where but also one of preparation—a host of mundane chores needs to be attended to, from double-checking gear to bringing on ice to fine-tuning reels. And most of those tasks fall to the boat's mate, and in the *Sensation*'s case that was Alan, who had been Britt's mate for a number of years. Alan was young, as

PHOTO 8. Big game reel and lure. Courtesy of Tom McMurray.

are most mates, agile, and extremely competent in his duties, particularly at rigging baits—turning dead fish into an alluring meal. To most mates, reeling in a hooked billfish is relatively boring, nothing more than repetitive "crankin." The real reward for the mate is when a marlin rises from the depths to inhale a bait that he or she rigged by hand.

One of the primary baits used by almost all tournament boats is ballyhoo (*Hemiramphus brasiliensis*)—a small (six to ten inches), silverish saltwater fish. Ballyhoo are members of the halfbeak family, which derives its name from the members each having a prominent bill or beak. While it is hard to beat freshly caught ballyhoo as a bait, tournament anglers rely on frozen ballyhoo that has initially been preserved in a cold, briny slurry to prevent discoloration and toughen it up.

Most fish have particular feeding habits and mannerisms that dictate whether they will strike a bait or spurn the offering. The billfish views the bait in a specific way. If the appearance or movement of the bait appears unnatural to the fish, the angler's chance of attaining a solid hookup decreases dramatically. Success depends on presenting the bait in a natural manner—positioning it at the proper depth and controlling its movement through the water. (Fly anglers, who have been on the fishing scene a lot longer than big-game anglers, can also attest to the importance of positioning. They know that a dry fly that does not float high enough on the water or drifts unnaturally in the current due to line drag will more often than not be spurned by a wary trout.)

To achieve this end, the mate must prep the ballyhoo before rigging. First, the frozen ballyhoo is allowed to thaw in a bucket of saltwater. Once thawed, the eyes are removed, which helps in rigging. The back of the ballyhoo is then broken by gently massaging the body from front to back—a huge step in making it flexible for the appearance of swimming when it is towed by its nose. Finally, squeezing the fish's stomach cavity removes any fecal matter. The end result should be a fish that is limber, devoid of any stiffness, and exhibits good swimming action.

Rigging of ballyhoo with circle hooks is different than with J hooks. In the latter case, the hook passes through the cavity of the fish and exits out its bottom. The circle hook's geometry would entail a different rigging strategy. In 1996, Captain Ron Hamlin, fishing with Captain Peter Wright and angler Skip Watson in Guatemala, experimented with

different hook placements. None seemed to work until Hamlin told his mate to try attaching the hook to the top of the head. They were pleasantly surprised to find these head-rigged baits worked extremely well. Hookup ratio was high, catch percentage increased, and all fish were hooked in the corner of the mouth. Head-rigged ballyhoo would become de rigueur in billfish tournaments.

Throughout the tournament, Alan kept on ice a good supply of rigged ballyhoo, ready to be deployed at a moment's notice. While ballyhoo may be rigged either naked or dressed, Alan attached to each bait different skirts (an artificial lure that slides down the line's leader and over the nose of the ballyhoo), counting on the color and flash of the skirt to act as a visual stimulus to a curious billfish.

But Alan also adhered to the old fishing maxim: big baits for big fish. And this is where Spanish mackerel, members of the Scombridae family, which also includes tuna, came into to play. These elongated (fifteen to twenty inches), streamlined fish have proven quite successful as baits in billfish tournaments. (Hatteras-based captain Steve Coulter won the 2009 Big Rock Tournament when a 466-pound blue marlin ate his mackerel rig.) The preference of blue marlin for scombroids appears to be backed up by scientific research. Paul Rudershausen and his fellow researchers examined the dietary habits of blue marlin for over a ten-year period from specimens at the Big Rock Tournament and found that scombroids were an important prey of blue marlin—a diet that included relatively few other prey species. They referred to this selectivity as "low dietary niche width."

Alan, like a surgeon, carefully removed the mackerel's spine to increase its flexibility and just as efficiently sewed the mackerel back up. He inserted a circle hook through the mackerel's pointed snout and attended to one last detail: trimming the lower lobe of the mackerel's tail. I have heard that the pectoral fins of the ballyhoo are often cut off, so that it doesn't roll from side to side when it is towed in the water. I know a little bit about water flow over an object, so I thought that maybe Alan was meticulously enhancing the hydrodynamic profile of the mackerel. Inquiring into the reason for the clipping, I was deflated, rightly so, by Alan's response: "because the tail was uneven." A triumph for aesthetics over science.

But presenting a variety of offerings to a finicky billfish can mean the difference between a solid hookup and complete rejection. Alan used not only circle-hooked ballyhoo and Spanish mackerel but also a few J-hooked artificial lures.

The rest of the crew, who fished all of *Sensation*'s four days, were for the most part not professional anglers, though a couple had run charters in the Florida Keys, but were there for a bit of adventure and camaraderie. Their sponsor was back in Morehead City, vicariously experiencing the excitement of the Big Rock Tournament through them.

With all aboard, Britt headed *Sensation* out to the fishing grounds. The *Sensation*, like most tournament boats, was engineered and constructed to spend the day fishing in rolling seas and strong currents. Built in North Carolina, the *Sensation* was fifty-three feet in length, diesel powered, and equipped with all the modern-day electronics. Three fighting chairs in the aft cockpit completed the necessary accessories. A far cry from the days of Ernal Foster and other Hatteras captains who went to sea without depth finders and global positioning systems and relied on the Cape Hatteras Lighthouse and the Diamond Shoals Lightship to get their bearings.

On his first day out, Britt spotted a billfish in about 75 fathoms (450 feet) of water, but he opted on the second day to fish initially the deep (over 300 fathoms) blue water. Geologically speaking, we were fishing over the continental slope, an underwater feature where the ocean floor precipitously plunges from the relatively shallow continental shelf to thousands of feet below the surface. Undersea slides and slumps on the relatively steep continental slope have formed holes, ledges, boulder fields, and depressions that attract a variety of fish.

At exactly 9:00 a.m., the VHF radio crackled with the announcement "lines in"—fishing commenced. Alan immediately began to set out a total of seven fishing outfits, four reels spooled with 30-pound test line and three with 80-pound test, which formed the trolling spread.

Like a spider web, these lines radiated to the port, starboard, and stern of the boat. To obtain maximum spread of the lines and avoid their tangling, Alan attached four of the lines to the outriggers on either side of the boat. (The outriggers had release clips attached to a nylon line running along the pole like a halyard on a flagstaff. The

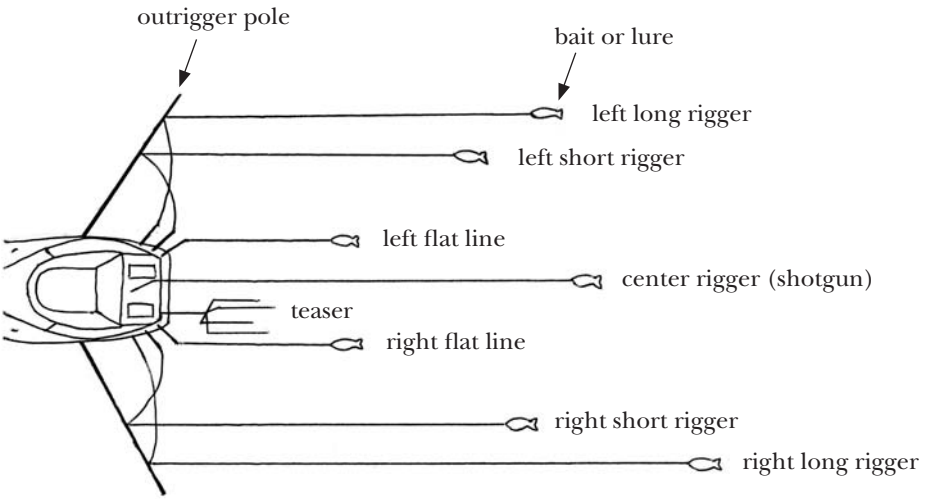


FIG. 5. Trolling spread. Courtesy of Rebecca Bunker.

main line from reel was attached to the release clip, which when under pressure from the strike of a fish, snaps open to allow the angler to fight the fish.) The result was two lines, one short and one long behind the boat, on the starboard side, as well as two more on the port side. To complete the spread, Alan passed two rods up to Britt in the upper helm, who positioned two additional baits behind the center of the boat. The longest line streaming behind the boat is known as the "shotgun rig." And from the boat's stern, Alan employed what is known as flat line into the water, which because of its low angle minimizes tangling and keeps the bait just below the surface. Also added to the bait spread was a daisy chain, which is simply a string of in-line plastic teasers (hookless, molded plastic lures), used to attract fish to the boat and excite them to strike the bait. If a fish latched on to a bait, the shout of "left, short outrigger" would ring out to alert Alan to which outfit needed his immediate attention.

The dragging or towing of the baits and teaser by the boat is called trolling, probably the most productive and favorite method of

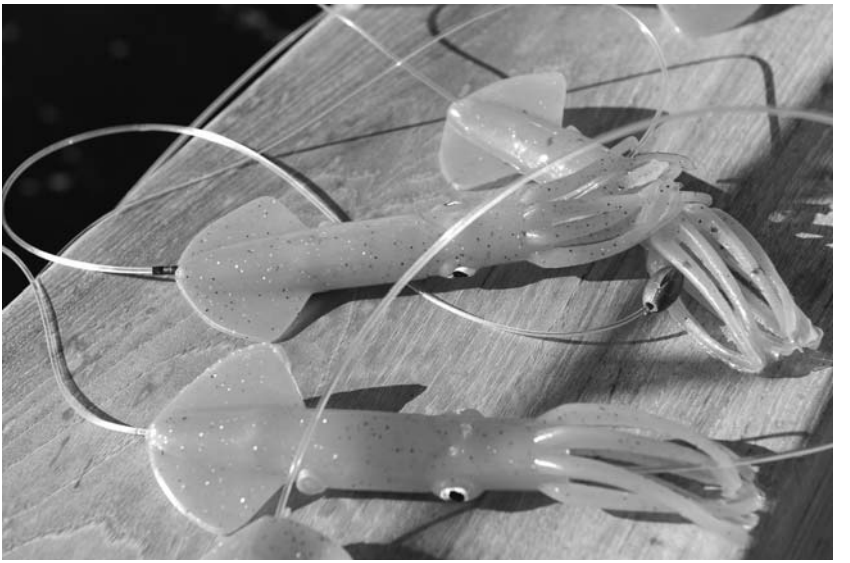


PHOTO 9. Squid teaser. Courtesy of Tom McMurray.

the offshore angler because at its core is the art of mimicking free-swimming prey. Britt got the *Sensation* up to trolling speed, generally between six and eight knots, which resulted in the shallow running baits skipping enticingly along the sea surface. This method is particularly effective on most offshore game fish, including blue marlin, which feed on schools of bait located near the surface.

Once Britt set the *Sensation* on course and the trolling spread was set, all aboard settled into their respective routines. For the anglers, it was sitting back and waiting. Trolling involves long periods of inactivity interspersed with moments of frantic activity when a fish is hooked. For Alan and Britt, it was keeping a watchful eye on the baits. To the untrained observer, the sea appeared as an endless blue mat, interrupted by frothy whitecaps and the bubbly trails of the towed bait. But they looked for signs: the flash of color streaking across the spread, a dorsal fin slicing through the water, or the sudden up thrust of a long bill, all of which may indicate that a billfish took an interest in their offering.

Britt shouted down that a blue marlin was caught and released by the boat *Trophy* at 9:16, only minutes after the lines went into the water. This catch earned the crew over $4,200 in prize money as the first blue marlin released on that day. (On the previous day, the first blue marlin caught was disqualified because it was severely cut accidently by the propellers of a boat that was backing down—reversing to aid the angler in fighting the big fish.) By 9:29, another blue marlin was released by the boat *Job Site*. In less than thirty minutes of fishing, two marlin had been caught, but to put that number in perspective, 121 boats were on the water, all searching for the same quarry.

For a marlin to be considered officially caught, the mate must, at the minimum, grab hold of the leader—a heavy line between the main line and the lure or bait. The mate exerts enough pressure on the leader to control the fish in order to remove the hook for a release. For small billfish, like white marlin, the procedure is relatively straightforward, with minimal risk to the mate, but anxiety levels rise when a big blue marlin, five hundred pounds and above, is hooked. Its strength and unpredictability can lead to a potentially dangerous situation. All seasoned mates must be adept at wiring the fish—properly handling the leader to control the fish near the boat. The term *wiring* dates back to the days when the leader material used most often was wire, as compared to monofilament line commonly employed today. Regardless of the material, the technique has changed little over time. The mate's first move is to pinch the leader with one hand and attempt to move to one corner of the boat, preferably the one nearest to the fish. The latter procedure removes the fish from the turbulent propeller wash, allowing the mate to better see the fish and thus anticipate its next move. To be able to exert enough pull on the fish, the mate must then wrap a couple coils of the leader around his open hand and secure them by then closing his hand. While the very idea of being tethered to a wild beast may seem unnerving to the uninitiated, with the proper training, technique, and practice the mate can be in charge of any unforeseen situation. If at any time during the wiring process the mate is uncomfortable with the lay of the wraps or the fish starts to pull too hard, becoming uncontrollable, he can simply open his hand to let the leader come flying off his hand. This is called dumping the leader, and

as long as the angler has maintained some minimum reel drag to keep the fish near the boat, the mate can give it another shot.

But there are times that it is genuinely dangerous. During a 1994 tournament in North Carolina, a crewman was attempting to release a blue marlin when the fish suddenly lurched away from the boat, violently yanking the leader that was wrapped around his hand. In an instant, he was overboard, with the marlin dragging him down. A fellow crewman immediately dove into the water to save him and spotted the mate and the marlin more than thirty feet below the surface. No match for the power and speed of the marlin, he was unable to rescue his friend, who disappeared from view into the abyss.

Successful offshore fishing requires flexibility and adaptation on the part of the captain as to what the sea may offer up on any given day. In his 1936 *Esquire* article, Hemingway expounds on the fickle nature of the Gulf Stream: "In a season of fishing you will see it oily flat as the becalmed galleons saw it while they drifted to the westward; white-capped with a fresh breeze as they saw it running with the trades; and in high rolling blue hills the tops blowing off them like snow as they were punished by it."

Britt trolled both with and against the current. In the latter case, an opposing wind results in short and choppy seas, necessitating slower trolling speeds in order to keep the baits in the water. Britt's task was in principle simple enough: to coax a blue marlin from the depths to latch on to a slab of bait. But raising a fish is not catching a fish, nor is it even hooking the fish. Billfish may show minimal interest in the bait, following it but refusing to strike. To trigger their feeding instinct, the trolling speed is increased, if sea conditions warrant, making the bait swim faster and skip more energetically. Often this technique will draw a strike because at its core, it simulates a prey that is attempting to flee.

Another blue marlin was caught and released at 9:51 by the *Gambler*, which was based out of Hatteras Harbor Marina and has essentially been fishing the same general area as *Sensation*. As this news spread among us, a good-natured grumbling emerged from the cabin: "Who brought the bananas?"

How did this nutritious fruit come to be viewed as bad luck on a boat? Superstition is ingrained in maritime tradition, and probably no

other lore holds sway more with a boat's crew than that having bananas aboard will jinx the vessel. The stories are many as to why bananas gained their notorious reputation, and many of them date back to the seventeenth century—a period when the world's oceans were crisscrossed by wooden sailing ships. The Spanish had set up trading posts throughout the Caribbean islands, and one food staple that was often bartered was bananas—a new and exotic commodity to the Spaniards. Transporting these goods often involved sailing through dangerous and uncharted waters, where many hazards could, and did, befall these vessels, resulting in shipwrecked or scuttled ships. The only visible remains of these sinking ships might be clumps of floating bananas, leading witnesses to conclude that hauling this cargo brought to bear the wrath of the sea gods on these doomed vessels.

Another variation of the above story is that the bananas would over time become infested with all types of pests, such as bugs, spiders, and vermin, which would ultimately find their way into the captain's quarters. Outraged that his sanctuary had been invaded, the captain would be more than willing to spin a tale of bananas being bad luck for the ship and its crew, thus banning the "evil" fruit from being brought onboard.

With no one on the *Sensation* secretly harboring a stash of bananas, maybe our luck was changing; Britt spotted a long line of sargassum weed, stretching well off into the distance. This flotsam line had developed along a well-defined rip. What a beautiful sight. And best of all, there were no other boats in view; we were able to probe the weed line unimpeded. The *Sensation* ran parallel to the weed line, trolling as close to the sargassum as possible without the baits becoming entangled in it.

Alan, now covered from head to toe, including a balaclava, to ward off the strong early summer sun rays from his fair skin, carefully monitored the swimming action of the baits. Any tendrils of sargassum must be promptly shaken off from the bait, lest they affect the movement of the bait through the water. To keep a bait looking natural, Alan periodically yanked down hard a few times on an outrigger line to remove the weedy appendage. It's an act that he repeated many times throughout the tournament.

The water was gin clear, and from my elevated position in the boat's helm, I could peer deep down below the sargassum, searching for any

shadowy form lurking in the depths. A quick movement to my right caught my eye—a flying fish skimming across the rolling swell. Its stimulus for flight was the pressure wake from the *Sensation*, unfortunately not a hungry predator.

For over a half hour, we trolled the sargassum line, both sides of it, with the current and against it. All to no avail. The line proved unproductive—the sargassum was devoid of any baitfish, and the billfish sought out more fertile waters.

Britt was philosophical about the lack of billfish action, disappointed but not discouraged. A story emerged. As a young man, starting out in the charter business, he had attended an after-tournament party, hoping to pick up some morsels of fishing advice. Sensing his eagerness, an elderly woman summoned him over. She was Kay Rhybovich, matron of one of the premier boat-building families of the twentieth century and an accomplished angler in her own right. "Want to find the fish?" she whispered. "Then first find the bait." Simple advice, not complex, but wisdom that Britt long ago adopted and held fast to. We motored on—trolling, watching, waiting, and searching for bait.

The rumble of the diesel engines was slightly muted by the sound of music coming from the cockpit. The relationship of music and seafarers is an ancient one.

The Sirens of Greek mythology were dangerous creatures, portrayed as seductresses who with their enchanting music lured nearby sailors to run aground on the rocky coast of their island. The poet Homer gives the Sirens their due in the *Odyssey*, relating how their beautiful voices sung out to Odysseus, who resisted the temptation by imploring his crew to put wax in their ears and to bind him to the boat's mast.

By the mid-nineteenth century, the word *shanty*, though of uncertain etymological origin, emerged in reference to a distinct genre of work song, sung by the crew of square-rigged sailing ships. The melodic rhythms of the shanties coordinated the shipboard labors of the sailors, such as hauling the lines of the sails. With the advent of steam-powered ships, the shanty fell into disuse, for it ceased to serve a practical function.

While aboard his beloved *Pilar*, Hemingway would play jazz pianist Fats Waller and composer Cole Porter records on a scratchy phonograph. He firmly believed that the songs were good for bringing up the

fish that were lurking deep in the Gulf Stream. And if the mood struck him, he'd belt out his own siren song.

Today's playlist on a fishing boat can be quite broad, ranging from traditional shanties to reggae to contemporary pop fare with a nautical theme. But there are limits; like bananas, rap and classical music rarely, if ever, find their way onboard. And yet on almost every charter that I've been on, the tunes of singer-songwriter Jimmy Buffett can be heard, from "Margaritaville" to "A Pirate Looks at Forty." Buffett's Caribbean-boating-partying motif has thoroughly infused the fishing scene for years.

From down below, a shout echoed throughout the boat: "Where are the freakin' fish?" It seemed the music had little effect on the fish or the jangled nerves of the anglers. The frustration was heightened with the knowledge that there was just a little more than two hours of fishing time left on this day, and there hadn't been a bite of any type—never mind a billfish, not even a dolphin or wahoo to break up the boredom. And the boredom can be numbing, made all the worse by the seemingly endless staring into the harsh, sunlit sea. The tension eased a bit when some beers were passed around, a ritual as old as big-game fishing. Hemingway, well known for his legendary drinking bouts, reflects on this ritual in *Hemingway on Fishing*: "Well, here we have Piscator, as Walton puts it, sitting on a chair which, with the heat, has given him that unattractive condition called fisherman's seat, holding now in his hand a cold bottle of Hatuey beer, and trying to peer past his monumental schnozzle and out over the sea which is doing considerable rising and falling."

Some of the beer found its way into the sea as an offering to the sea gods. Why not? As of yet, the gods, whomever they may be, had not offered up any billfish. My thoughts wandered to the Vikings, who with dozens of gods and goddesses to choose from could easily find a deity to blame their seafaring misfortunes on. My particular favorite is Aegir—the personification of the sea, be it good or evil. When angered, he would hurl down storms on the offending seafarers. Norse storytellers said that when a ship sailed into "Aegir's wide jaw," all aboard were taken to his fortress at the bottom of the sea. For another gift, I ceremoniously placed a dollar bill under a few coils of line on one of the reels, hoping that this reel would be looked on favorably. (I have heard that

PHOTO 10. Discarded white marlin with bill removed.
Courtesy of Tom McMurray.

some Australian big-game anglers use a hundred dollar bill. Their gods must be infinitely harder to please.)

Time passed; the reels remained silent; and the sea refused to offer up any billfish. I removed the dollar from the reel and tossed it into the sea anyway, realizing that this was not our day. At its core, catching billfish, or for that matter any fish, can be boiled down to three factors: knowledge of the nature of your quarry, mastery of the appropriate angling skills, and, yes, luck.

With fishing time winding down, Britt motored *Sensation* into shallower water, seventy-five fathoms, hoping that the blue marlin he had seen the previous day would revisit this area. A last-ditch effort, but we fished until the end, which came promptly at 3:00 p.m. with the announcement of "lines out."

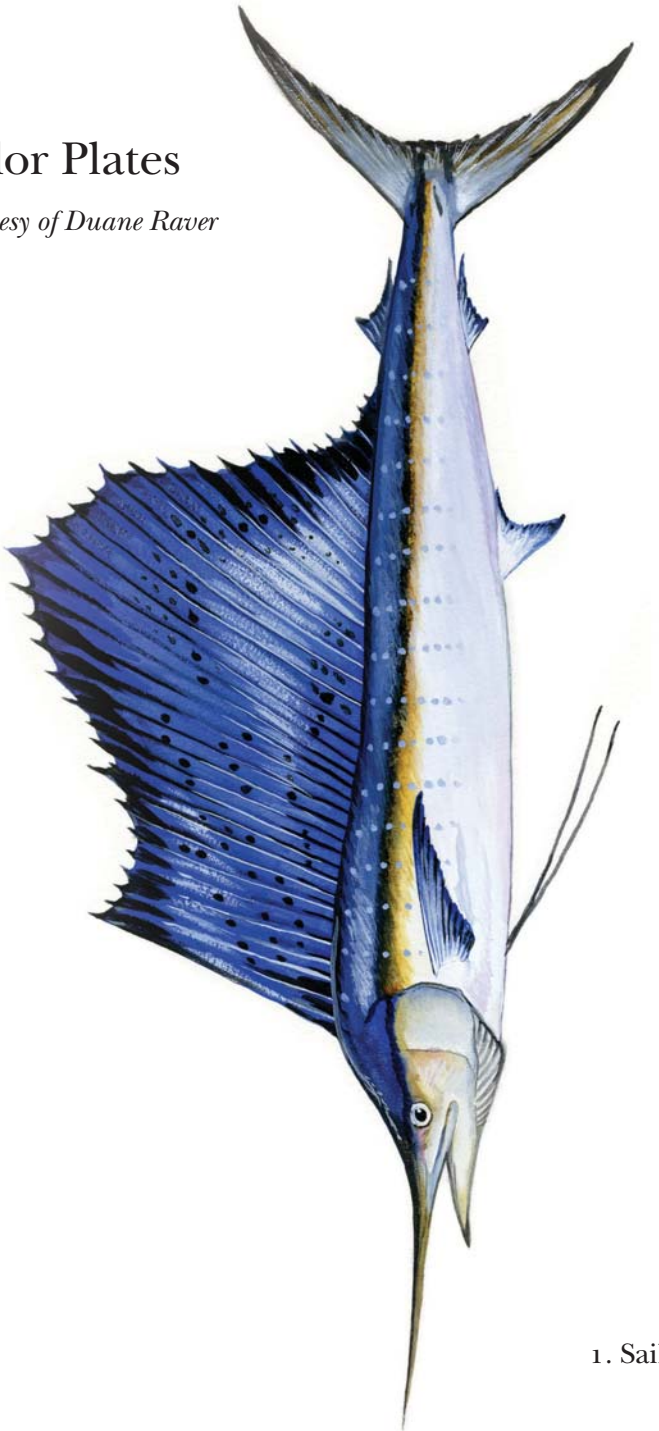
There were some, but not many, "lucky" anglers on that day. Only six blue marlin and three white marlin were caught and released by the fleet. But perseverance would pay off for the *Sensation* crew. On Thursday, their last fishing day, they caught and released two white

marlin, but they pulled the hook (J hook lures) on six others and two blue marlin. Britt fished these fertile waters with only one other boat in sight, the *Release*, for more than two hours until the bite shut down with the arrival of additional boats. (The *Release* took home the top prize, $56,944, in the release division, recording one blue marlin and six white marlin.)

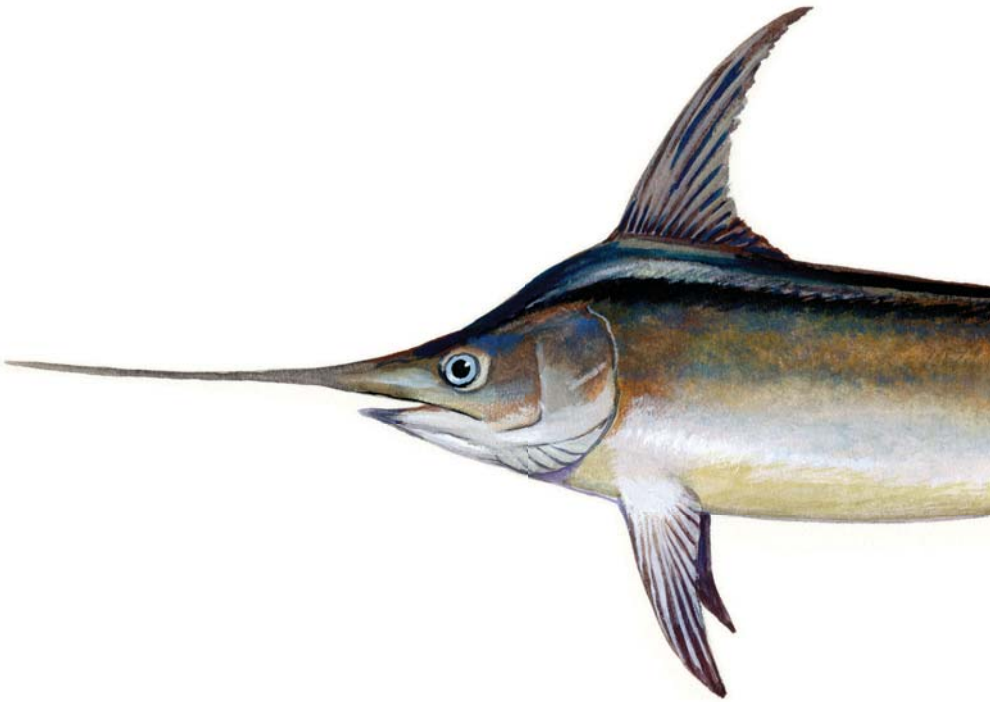
But the crew of the *Double B* experienced the highest of the highs, walking away with the top prize of $542,375 for catching the largest blue marlin. The huge fish was caught on the first day of the tournament by Travis Stephenson and tipped the scales at a whopping 652.8 pounds. But the crew, including the captain, Kenny Sexton, had to wait an agonizing five days to be officially declared the winner, when the rest of the fleet could not bring a bigger marlin back to the docks. When the clock struck 2:00 p.m. on Saturday, signaling the end of the tournament, the celebration kicked into high gear, with the first act being Sexton thrown into the Morehead City Marina Basin by his jubilant crew.

Color Plates

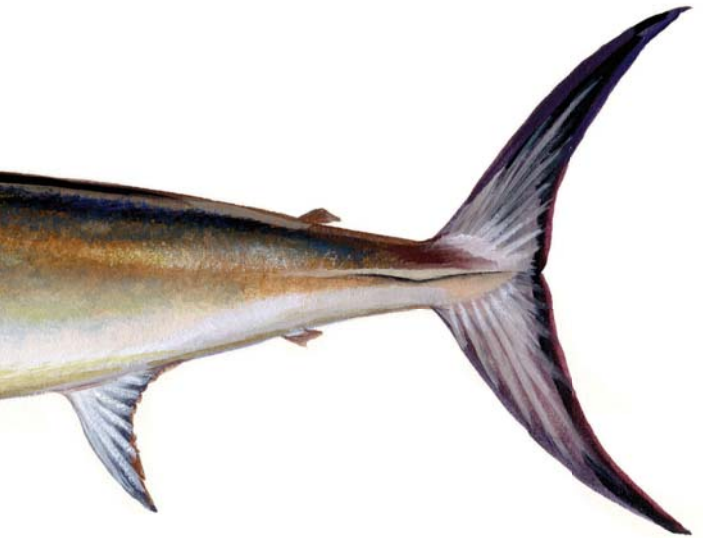
Courtesy of Duane Raver

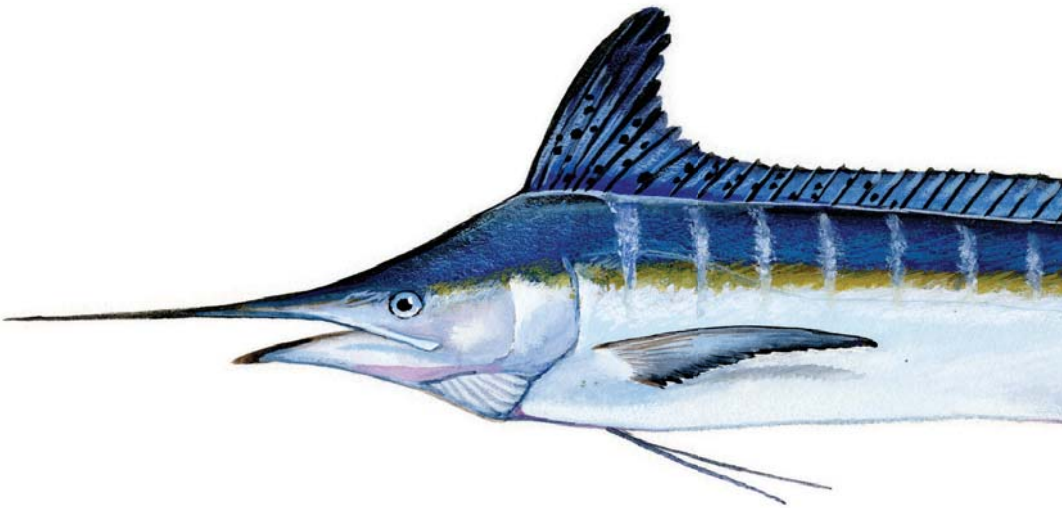


1. Sailfish

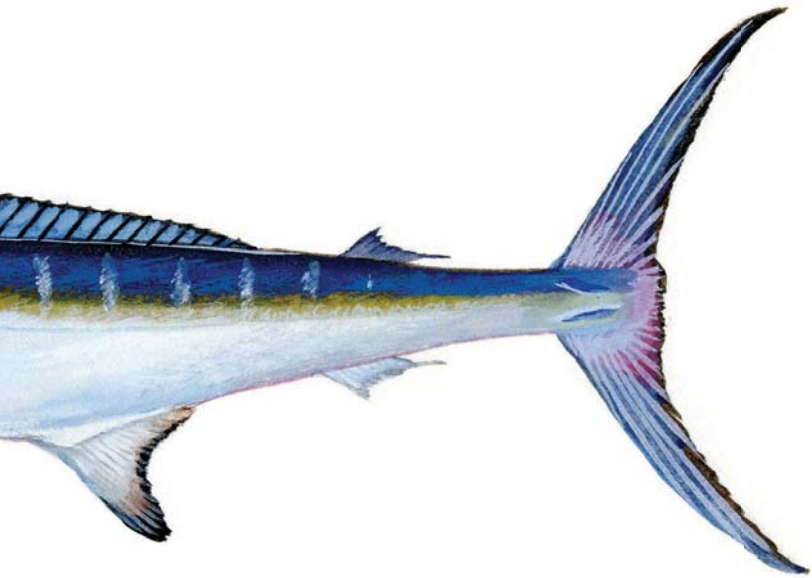


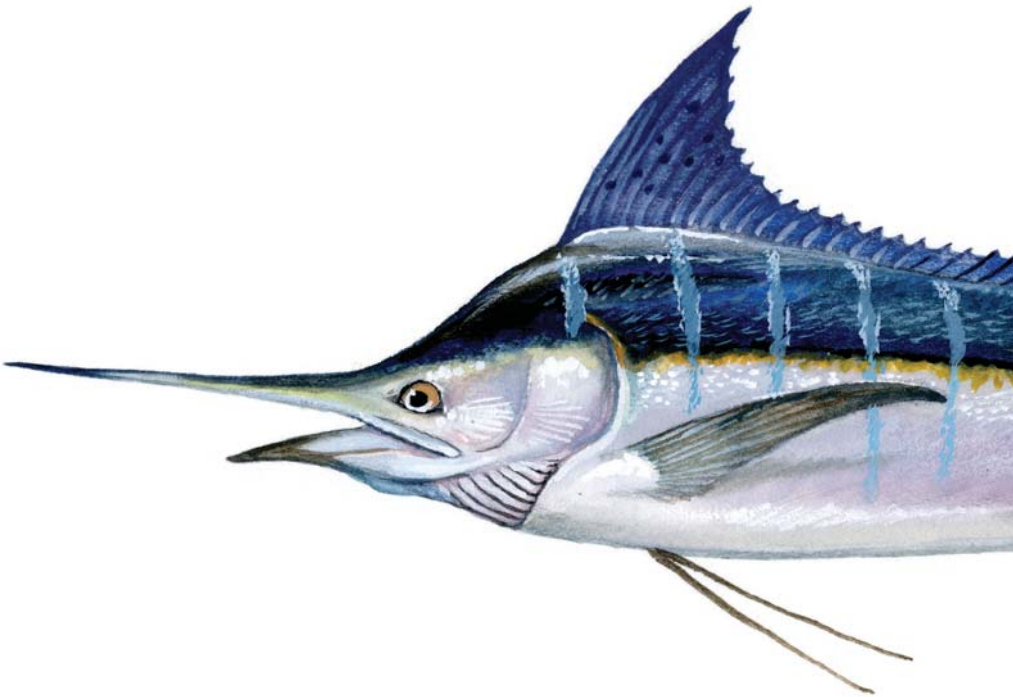
2. Swordfish



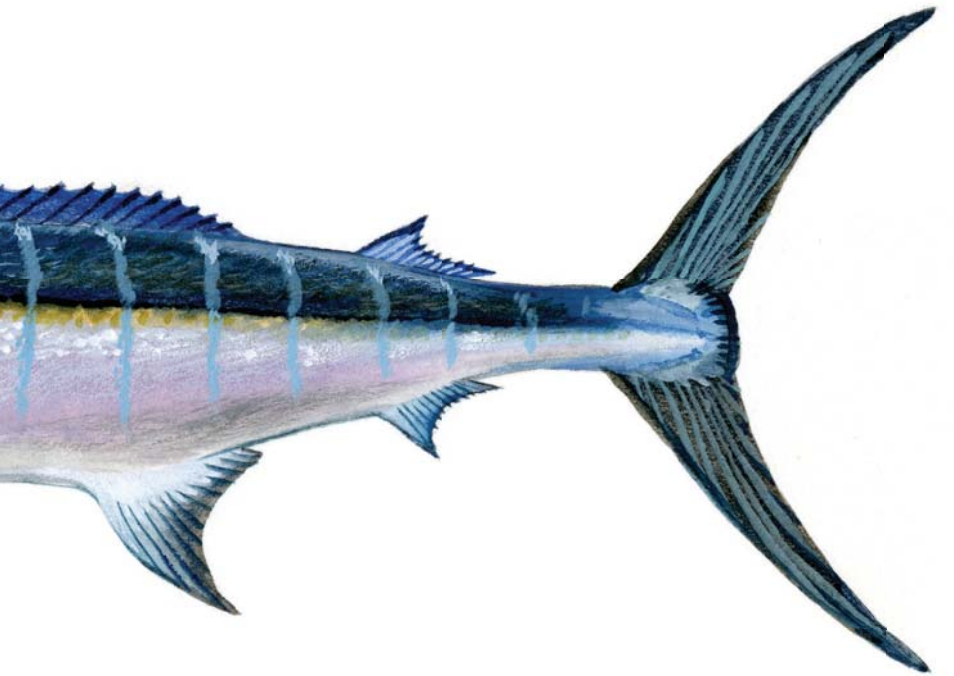


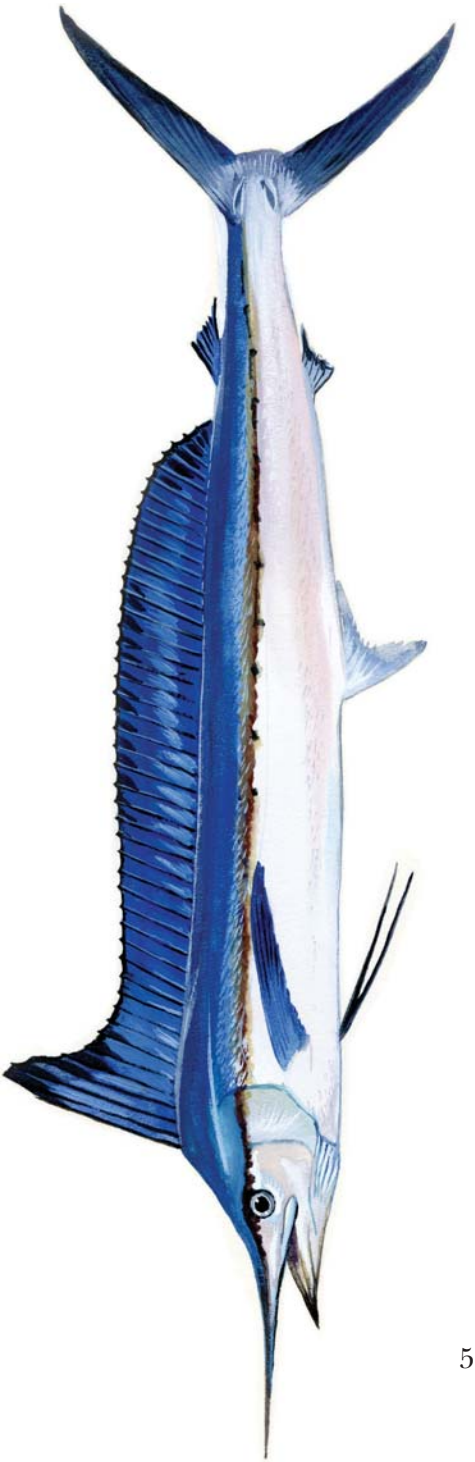
3. White Marlin





4. Blue Marlin





5. Spearfish

5

The Ultimate Billfish

BLUE MARLIN

The captain's cry—"long, left outrigger!"—sent the mate scurrying over to that side of the boat. Even as Dan grabbed hold of the 80-pound test outfit, removing it quickly from the gunwale's rod holder, line continued to peel off the reel at an eye-blurring pace. Shouts of "blue marlin" rang out, and in the distance, I saw a dark form streaking toward the horizon. By now, Dan had the situation under control. With the fish well hooked, he slid the lever drag to the strike position, with the intent to exert enough pressure on the fish without breaking the line. The fight was on, and this fight was mine. I was already in the fighting chair when Dan positioned the butt of the rod in the gimbal at the base of the chair. The fish continued to make a strong run in spite of about forty pounds of drag from the reel. All I could do at this stage was watch the revolutions of the reel, but Dan cautioned me to start reeling as soon as the marlin stopped taking line. As with all big fish that have taken several hundred yards of line from the reel, it was imperative to retrieve as much line as possible to minimize the effect of water friction, which could cause line failure, and to prevent any slack in the line. A taut line keeps the hook firmly embedded in the fish's jaws. "Tight lines" is the mantra of the angling establishment.

In the next instant, the reel had gone silent. Questions ran through my head: Did the marlin know it was still hooked? Had the hook pulled? "Reel," cried Dan, and I was immediately drawn from my introspective musings into a cranking mode. The line became taut; I felt the pressure; the fish was still on. Reeling became a painful chore as my fingers cramped and forearm muscles strained from the pull of the marlin,

which had decided to sound deeply. I was slowly gaining line, but that small victory abruptly ended when the marlin made another run. All the line that I had retrieved was gone in an instant. I visibly sagged. For the next thirty minutes, the struggle continued, but I appeared to be gaining the upper hand—the reel was filling with line. From my vantage point in the chair, I could not see the fish as my efforts slowly drew it closer to the boat. But Dan could and instructed me to stop reeling. He touched the leader, making it an official catch. Taking a couple wraps of the leader, he removed the hook from the tired marlin without bringing the fish into the boat. I could now see my marlin, which Dan estimated to weigh about three hundred pounds. Not a "grander" (a giant marlin weighing over one thousand pounds) by any means, but a worthy adversary nonetheless. On the way back to the marina, Dan ran up a blue marlin flag on the boat's outrigger. It flew upside down, a recognized sign of a successful catch and release of a billfish.

A Picture Emerges

Bernard Lacépède first described the blue marlin, *Makaira nigricans*, in 1802. But over the years the taxonomic status of the blue marlin has come up for debate within the scientific community: where does the blue marlin fit in the Istiophoridae (billfish) family tree? The prevailing belief was that the blue marlin was most closely related to the black marlin, also of the genus *Makaira*. The blue and black marlin can be hard to tell apart—a fact that Hemingway could attest to: the back of both species is dark blue, and the flanks and belly are silvery white. Also, there may be light blue or lavender stripes on the sides, and their dark dorsal fin is high and pointed. Another similarity is that both species exhibit strong sexual dimorphism, where the males are much smaller (200 to 250 pounds) than the females, which can grow to over 1,000 pounds. However, while all other billfish have a bill, albeit small, even when they are quite young, blue marlin do not sprout a bill until they are older and have attained a length of over three feet.

Modern molecular biological techniques, focusing on mitochondrial and DNA sequencing, were called on to solve this problem. Recent genetic analysis of billfish tissue samples by John Graves and

his colleagues unequivocally proved that the closest relative to the blue marlin is the sailfish, although their respective size and appearance differ markedly. They discovered that the genetic differences between blue and black marlin are significantly greater than those between almost any other pair of billfish species. Based primarily on this finding, the black marlin has been reclassified into the genus *Istiompax*.

Though the blue marlin's position in the billfish family tree has been determined, its status among billfish anglers has not changed: it ranks near the top, if not at the top, of game fish species. With a rare combination of size, speed, agility, and power, unmatched by other billfish, the blue marlin is capable of long, sustained runs, aggressive fights, prolonged deep dives, and acrobatic leaps into the air.

The blue marlin is a true pelagic species, found only in blue waters away from the continent. Its range in the Atlantic basin stretches from 45° north latitude to 35° south latitude, a distance of approximately five thousand miles. Preferring mainly temperate waters, the blue marlin is the most tropical of all the billfish. The species is more abundant in the western Atlantic due to the influence of warm currents, such as the Gulf Stream and the Brazil Current, than in the eastern Atlantic, which is affected by the colder Canary and Benguela currents. In the northern Gulf of Mexico, its location often coincides with the position and strength of the warm Loop Current.

Although widely distributed, blue marlin have specific, localized spawning sites, based on the presence of tiny larvae, in the western North Atlantic: the Straits of Florida; Punta Cana, Dominican Republic; Bermuda; and the Gulf of Mexico. Like most pelagic fish, female blue marlin release their eggs into the open ocean, where fertilization occurs by attentive males. These females are quite fecund; a four-hundred-pound marlin may produce 30 million eggs per year, and a large marlin of one thousand pounds yields 70–80 million eggs annually. The eggs are not released all at once but are expelled from the ovaries in batches throughout the summer spawning season. These multiple spawning events are a good reproductive strategy, probably ensuring the success of some of the batches if others fail. And the failure rate can be high. The whitish to yellowish buoyant eggs drift aimlessly on the water surface at the mercy of winds and currents.

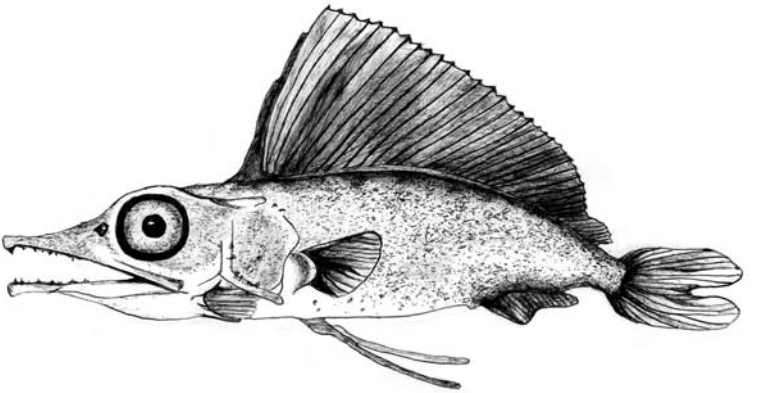


FIG. 6. Larval blue marlin (actual size is one inch).
Courtesy of Rebecca Bunker.

Though egg hatching depends on temperature, tiny blue-black larvae emerge from their encapsulated environment within about a week after fertilization. These strange-looking creatures, with disproportionally large eyes and mouth that will aid them in their search for food, grow rather quickly. But the very young marlin must run the gauntlet of a host of predators. In the first two weeks after hatching, 50 percent of the larvae will have succumbed, and by the end of the first year, losses approach 99.9 percent. Of the millions of larvae that have hatched, only a couple of thousand will be around for their first birthday.

The enormous amount of energy required to produce this prodigious number of eggs each spawning season may be one of the reasons female blue marlin attain greater size than their male counterparts. Biologists believe that the female's evolutionary fitness—her fast growth rate, early maturity, and large size—are indispensable for the species's survival through natural selection, as well as its continued success.

A Long-Distance Traveler

For adult marlin, the act of spawning is very strenuous, and the fish must compensate for the energy expended in procreation by increasing their consumption of food. With large appetites to satisfy, these

pelagic giants seek out sites where prey is abundant. Blue marlin have long been characterized by anglers and writers primarily as sprinters capable of short bursts of speed when pursuing a fleeing prey or a trolled bait. But recent tracking studies of marlin have yielded a markedly different picture: blue marlin are capable of remarkable long-distance migrations.

Soon after spawning, most of the adult marlin depart the spawning areas and migrate to as far north as the Georges Banks off of Massachusetts, following the general northward movement of prey during the summer months. The adult blue marlin will remain in these northern feeding haunts, gorging on a variety of prey items, including mackerel, dolphin, and tuna, until cooling water temperatures signal it is time to migrate south—an annual event as old as the blue marlin species. Another group of fish, possibly those that have spawned in the Gulf of Mexico, travels northward to the waters off the Gulf Coast states.

Jim Chambers, a fisheries biologist who has over the years intensively studied the ecology of many big-game fish, argues that "the fish we seek are not randomly dispersed over the entire ocean but concentrate in a series of relatively small areas." He refers to these areas of concentration as "hot spots" and has identified several feeding "hot spots" for blue marlin, including the Flower Garden Banks and the de Soto Canyon in the Gulf of Mexico, and the Charleston Bump and the aforementioned edge of the continental shelf from just south of Cape Hatteras to the eastern tip of the Georges Bank in the western North Atlantic. All of these sites, though different in appearance and geological setting, offer what all blue marlin want—an abundance of prey.

The Flower Garden Banks is one of fourteen federally designated underwater areas protected by NOAA's Office of National Marine Sanctuaries. Situated 70 to 115 miles off the coasts of Texas and Louisiana, the Flower Garden Banks Sanctuary, named for its brightly colored sponges, plants, and coral, includes a host of biological communities that sit atop underwater hills known as salt domes. The sanctuary actually protects three separate areas: East Flower Garden Bank, West Flower Garden Bank, and Stetson Bank. These banks are separated from each other by miles of open water, where depths range

from two hundred to four hundred feet. The fertility of this area is primarily the result of current-induced upwelling, such as from the Loop Current, which will often extend as far north as to the edge of the Gulf of Mexico's continental shelf.

The de Soto Canyon is a deep (2,400 to 3,000 feet) and vast submarine valley that cuts through the broad continental shelf of the Gulf of Mexico. The northern end of the canyon is more than fifty miles from the Florida coast, entailing a long run for the blue-water fleet. As with many prominent bottom features, an upwelling of deep, nutrient-rich water occurs here, resulting in high biological productivity. The end result is more food available throughout the oceanic food chain.

The Charleston Bump (80 to 100 miles southeast of Charleston, South Carolina) is a series of underwater scarps, rocky ridges, overhangs, and caves. Located on the relatively flat Blake Plateau, the bump rises upward over a thousand feet from the ocean floor and exerts a strong influence on the Gulf Stream that flows directly over this topographical feature: deflecting the flow offshore, initiating the formation of permanent and seasonal eddies, and resulting in upwelling of nutrient-enriched subsurface waters to the sunlit surface waters, which enhances plankton production and prey for hungry predators. The combination of myriad underwater features and complex current flow attracts blue marlin as well as many other species. From the summer through the fall of every year, migrating blue marlin congregate in the waters around the Charleston Bump, feeding on the cornucopia of prey organisms.

The need to spawn and feed drives the blue marlin on its long and arduous migrations, and currents, the great rivers of the oceans, are their conduits. Many aquatic species, both fresh and marine, are rheotactic—their movements are a response to the flow of water. Fly anglers know that trout will orient themselves to face upstream into the river flow, and tracking studies have revealed that marlin prefer to migrate by means of favorable ocean currents, like the Gulf Stream.

How these fish navigate across hundreds of miles of a featureless ocean is in many aspects still a mystery, but the current thinking revolves around a number of environmental factors: thermal fronts, the electromagnetic fields generated by a flowing current, and scent

trails. Data generated from the commercial fishing industry show that most marlin are caught along the western edge of the Gulf Stream, which exhibits the greatest horizontal temperature change of all the currents in the North Atlantic, as they migrate northward. Marlin have lateral lines that run down their midsection, allowing them to detect movement and change in their surroundings by sensing magnetic field and electrical impulses. The organ responsible for this is the neuromast, a cluster of very tiny hairlike cells. All billfish possess free neuromasts, which come in direct contact with the water and are arranged in a particular pattern to form the lateral line. For the Pacific blue marlin the lateral line is a series of loops, like a chain, but the Atlantic blue marlin's lateral line is a netlike pattern of hexagons, which is more complex than its Pacific counterpart. In general, active swimmers have more neuromasts than sedentary organisms.

While marlin are primarily visual predators, they may rely on their sense of smell to determine their orientation in their watery environment. One hypothesis is that marlin use the chemical signature of an ocean current to navigate, similar to a salmon returning to its natal stream by sensing the stream's particular brew of chemicals.

The migration of the blue marlin is generally a solitary event; rarely do they congregate in even small groups. This tendency to not form schools may be a disadvantage to the long-distance marlin. While many fish species form schools that exhibit synchronous movements, bluefin tuna, also marathon swimmers, appear to exhibit a rigidly defined school structure, governed, in part, by their migratory rituals. Aerial surveys show one of the most common schooling structures is a parabolic formation—an arc usually limited to fifteen individuals and approximately two hundred feet wide. Brian Partridge and his colleagues at the University of Miami have defined the functional use of this unique geometrical configuration. They argued that the position of the fish in the school is such that individuals benefit, conserving energy, from the hydrodynamic interaction with their neighbor. Similar to porpoises riding the bow wave of a ship to gain some forward thrust, a tuna may "push off" the pressure wave generated by its neighbor.

While cooperative swimming would be a distinct asset for migrating marlin, the rigors of long migrations necessitate that the individual marlin must be proficient at propelling its body, which is immersed in a relatively high-density fluid. Propulsion only occurs when thrust overcomes drag, a frictional effect that impedes movement through a fluid. Natural selection will have favored those anatomical and physiological traits that aid in decreasing the energy needed for sustained swimming. With millions of years of evolutionary development on the blue marlin's side, this species is well adapted to its pelagic environment.

One of the main speed-sapping effects that marlin must overcome is the pressure drag, which is a function of the volume of water that must be "pushed aside" by a moving body. How does the marlin minimize this drag? For that answer, we must look at the basic physics of different objects immersed in a fluid and ultimately the morphology of the marlin. Pressure drag increases proportionally to the cross-sectional area of the body in question. A flat object, for example, oriented perpendicular to the current would experience significant drag. On the other hand, empirical studies have demonstrated that this drag is significantly decreased when elongated objects are oriented parallel to the current.

Fish, like cars, often feature a shape that defines them. The shapes of a Ferrari and a marlin, for example, say—what else?—speed. Blue marlin, as do all billfish, have a streamlined body—fusiform shape—tapering at both ends from a thicker midsection. A marlin, endowed with this hydrodynamically efficient shape that results in a smooth, uniform flow of water over its body and minimizes the formation of a turbulent wake, can move efficiently and quickly through its watery environment. Interestingly, an important addition to the fusiform model was proposed by Sir George Cayley, a prolific English engineer, almost two centuries ago. He argued, and ultimately tested his hypothesis, that the shape of the rear portion of the object in question was just as important as the front section in decreasing resistance. For the marlin, the greatest degree of body tapering occurs at the caudal peduncle, which is anterior to the fish's tail.

We have previously seen that the bill of some billfish can aid in feeding or even be used as a weapon. But does it have a role in locomotion?

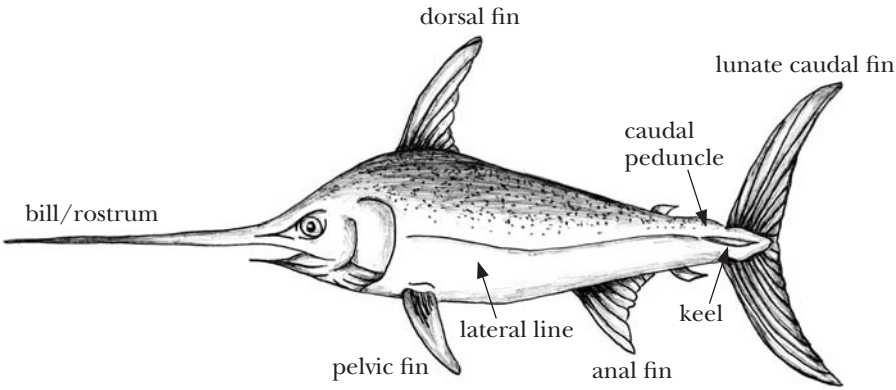


FIG. 7. Billfish anatomy. Courtesy of Rebecca Bunker.

To answer that question, we have to look at an analog in the aviation sector—a jet fighter plane. These planes often fly at supersonic speeds, and at these high speeds, the aircraft is moving so fast the air is compressed a great deal by the nose of the plane and cannot be easily displaced. So the shape of the nose is a critical factor in the aerodynamics of the plane, and an acute, pointy nose is best to avoid compressing the air. While the speed of the marlin is well below that of a jet, the fish's bill may similarly enhance its hydrodynamic profile as it attempts to overcome the drag of the high-density fluid it is immersed in.

Though the marlin is blessed with a fusiform shape and pointed bill, where does the thrust come from? Interest in fish locomotion dates back to ancient times. The first recorded references are from Aristotle, who implied that the pectoral and pelvic fins are used in a rowing manner to propel the fish through the water. In reality, propulsion in a marlin is a complex interplay between body movements and the caudal fin (tail). Until recently, marlin were viewed, based on morphological similarities, to have a swimming style comparable to that of tuna, which are known as thunniform swimmers. The rigid bodies of tuna exhibit little lateral motion when swimming. The rapid beats of their caudal fins are the only noticeable motions. But video analysis of free-swimming marlin and biomechanical studies of their backbone have shown that

marlin are quite flexible, generating undulating, wavelike body movements and swimming with a sinuous motion. These subcarangiform swimmers derive their thrust from the alternating sweep of the caudal fin, which exerts a significant back pressure against the water, and from the displacement of water due to the undulating body motions associated with swimming. The flexible caudal peduncle can sweep through large amplitudes to drive the caudal fin, but on the downside this generates drag. To offset this negative effect, marlin are equipped with double lateral keels on both sides of the peduncle that reduce drag during side-to-side motions.

The "motor" to drive the caudal fin resides in the fish's musculature. Marlin have a combination of white fast-twitch muscles and red slow-twitch muscle fibers. While the red fibers constitute only 5 to 6 percent of the total muscle mass, these vascular tissues contain high concentrations of myoglobin, a red pigment with a strong affinity for oxygen. Myoglobin delivers oxygen to cell mitochondria, which manufacture adenosine triphosphate, a high-octane fuel for the cells of the muscle tissue. These red muscles, inextricably linked to the caudal fin, are recruited for sustained swimming. Correspondingly, the white muscle fibers, though quick to fatigue, are essential for attaining bursts of speed, as when pursuing prey.

The nature of the caudal fin, which comes in a wide variety of shapes, sizes, and levels of stiffness, can be directly linked to a specific style of swimming, such as prolonged cruising or rapid acceleration. A useful function for assessing the swimming style of a fish is the aspect ratio of the caudal fin, a measure of its height in relation to its surface area. Long-distance cruisers such as marlin and bluefin tuna have caudal fins with high aspect ratios. These fins, generally crescent shaped, have a large spread between the dorsal and ventral lobes but a small surface area, which minimizes drag. The fin is very rigid and relatively useless for maneuverability but effective in straight-line motion.

A Well-Conditioned Athlete: Matching Morphology with Physiology

In the waters inhabited by blue marlin, food resources are at best spotty; therefore, marlin must minimize energy expenditures while swimming long distances. But how? To answer that question, researchers Barbara

Block, David Booth, and Francis Carey attached acoustic transmitters, which were capable of recording and sending data on water temperature, depth, and speed, to three blue marlin. They were surprised to find that, while marlin are indeed capable of short bursts of high speed, most of their time is spent swimming at slow speeds, one to two miles per hour, for extended periods of time within thirty feet of the surface. They concluded that slow swimming is a way to minimize the cost of locomotion over vast expanses of the open ocean—a hypothesis that appears to extend to other migrating fish, such as bluefin tuna and salmon.

Conservation of energy during long migrations might also be enhanced by the presence of a swim bladder. Observations of marlin displaying their dorsal and caudal fins high above the surface, commonly referred to as "finning," are evidence that the bladder, a thin-walled, multichambered sac, is large enough for the marlin to be positively buoyant near the surface. This buoyancy allows the blue marlin, and perhaps other billfish, to swim slowly near the surface and thus conserve precious energy reserves.

Hemingway's Santiago was pleased that his prized marlin "has jumped more than a dozen times and filled the sacs along his back with air and he cannot go down deep to die where I cannot bring him up." But to feed, marlin must overcome their positive buoyancy to sound for prey, and this necessitates high-speed swimming, albeit in short bursts. Observations have shown that they must increase their speed at the beginning of a descent to overcome positive buoyancy. At depths of 150 to 300 feet, marlin exhibit higher swimming speeds, which may be related to the deflation of the swim bladder. Negative buoyancy may be overcome by generating additional lift with the pectoral fins, which are swept back, like an airplane, and have large surface areas for lift.

Most pelagic fish, including billfish and tuna, have high metabolic rates, partly as a result of sustained swimming speeds. High metabolic rates require plenty of oxygen as the catalyst to convert food into energy. The dissolved oxygen in seawater comes from two primary sources: plant photosynthesis and exchange with the overlying atmosphere. But these processes are relatively inefficient; the net result is that seawater contains very little oxygen, only about 3 percent of the oxygen that the atmosphere contains. Even more distressing for a relatively warm water

species, like a blue marlin, is that water with a temperature of 80°F may contain 40 percent less oxygen than water at 45°F. But evolutionary pressures have made the marlin a highly adaptable animal, capable of extracting even this meager amount of dissolved oxygen. While tuna have the largest relative gill surface areas over which the dissolved oxygen passes, the gill areas of billfish are disproportionally larger than most other fish. And it also appears, though more morphological comparisons need to be made, that swordfish have the largest relative gill surface area among all billfish. This difference may confer a distinct advantage on swordfish. During the day, they are commonly found at depths over one thousand feet, where oxygen concentrations can be quite low. In contrast, other billfish, such as blue marlin and sailfish, spend much of their time in the top three hundred feet, where oxygen levels are six to seven times higher than in the realm of the swordfish.

To supply its gills with oxygenated water, a billfish must remain in a state of perpetual motion. Having lost the ability to actively pump water over its gills, a billfish swims with its mouth open, forcing water over the gills through its swimming action in a process known as ram ventilation. This mode of respiration is critical for the billfish's survival—if it stops swimming, it suffocates. While the need to move sufficient volumes of water over the gills is a problem for more sedentary fish, the billfish have sufficient water flow for ram ventilators; paradoxically, billfish must ensure that the water passes slowly and uniformly over the exchange surfaces of the gills, which is critical to gas exchange and oxygen uptake. To achieve that end, billfish have uniquely designed gills that increase resistance to water flow. In addition to minimizing energy expenditure, the blue marlin's relatively slow, sustained swimming speed may be the most efficient speed for irrigating the gills and extracting oxygen.

Most fish are cold-blooded, having an internal body temperature similar to that of the environment. In contrast, bluefin tuna and mako sharks are able to conserve metabolic heat and maintain elevated temperatures even when swimming in cold waters. These warm-blooded organisms can pursue and consistently catch fast prey, such as mackerel and squid. How? Some speculate that the flow of blood into the muscles warms these tissues, resulting in increased efficiency. But Barbara Block, David Booth, and Francis Carey have argued that warmer does

not necessarily mean faster, and they have observed the cold-blooded blue marlin reaching speeds that rival that of warm-blooded mako sharks. They agree that warm-blooded fish have the advantage of unimpeded performance through a wide range of water temperatures, extending their ability to forage in cold northern waters as well as feed in the chilly environment below the thermocline, a region that cold-blooded fish are reluctant to enter.

While some foraging opportunities may be out of the reach of the marlin during its migration, survival of the fish in the relatively trackless and featureless ocean ultimately depends on efficient predation, which in the clear waters of the Gulf Stream means that the marlin must be able to detect and distinguish different types of prey. As consummate predators, they rely strongly on visual perception. Almost 30 percent of their brain is devoted to processing and analyzing the visual signals coming from the eye. For a marlin to ultimately consume a fleeing mackerel, it must first detect the object in its field of vision, recognize the object as a food item, and expend the energy in pursuing and catching the prey.

Intelligent Life in the Ocean

When searching for its next meal, a marlin can be thought of as having four "choices" (setting aside for the moment the question of whether these are truly choices):

1. detect the object as being a food item and pursue it
2. detect the object as being a nonfood item and pursue it
3. detect the object as being a nonfood item and do not pursue it
4. detect the object as being a being a food item and do not pursue it.

The first choice leads to the optimal use of energy because the marlin expends resources in pursuit of a potential meal. The third choice is also good, since the marlin avoids expending resources needlessly. If the marlin chooses number two, it will waste energy resources; and if it consistently chooses number four, it will starve to death. A large female blue marlin weighing over five hundred pounds has obviously made the correct choice enough times during her lifetime to ensure her survival, growth, and potential to reproduce. Has the fish made

these correct choices purely at random, or does she have the mental attributes to discern which choice is best?

Big-game anglers take pride, and rightly so, in catching a trophy marlin, which requires planning, effort, and coordination among the crew. But has our intelligence been the overarching factor in catching them? Without a doubt, knowing one's quarry and deciphering the environment in which it swims are assuredly important. Throw in a little luck, and you have the keys to a successful fishing outing. But once the baits or lures are out, isn't the next move up to the fish? If the trolled bait appears to swim naturally and is a preferred food item of a hungry marlin, it seems likely that the marlin would decide that it is a food item and pursue it. But if the trolled bait has tendrils of sargassum hanging from it, the marlin "senses" or "decides" that something is not right and does not strike.

Can fish such as marlin learn? I know of no scientific study that has assessed this question. Such an undertaking would be a Herculean task, loaded with insurmountable obstacles inherent in the study of a free-roaming species in a vast, uncontrolled environment. But anecdotal evidence may give us a clue.

Recreational fishing for bluefin tuna in North Carolina exploded in popularity in the winter of 1994 when commercial fishermen discovered a massive concentration of these fish inhabiting shipwrecks about twenty miles from Hatteras Inlet. The technique for catching these behemoths was relatively simple: ladle overboard a bloody concoction of cut menhaden and other baits to draw the tuna to the surface, and impale a chunk of menhaden on a hook, toss it over the boat's stern, and hang on to a hooked bluefin heading straight to the bottom. But over time the fish became uncannily finicky—or at least that was the prevalent thinking of the anglers. Where once the bait could be impaled on the hook with the hook's point visible and hookups would be plentiful, bluefin tuna grew to avoid this setup assiduously, forcing the anglers to conceal the point in the bait carefully. Also, in the early stages of this fishery, the breaking strength and visibility of the line posed no problem—generally, the higher the test the better to subdue these beasts. But the fleet found itself downsizing and using fluorocarbon leaders, which are less visible in the water. Did the bluefin tuna

learn? Although there are no conclusive answers to this question, nor will there probably ever be, many anglers will remain convinced that the bluefin "learned" to avoid bait with a visible hook and also "recognized" fishing line as a threat.

Probing the Ocean Depths

The ability of any fish to see, whether it be prey or fishing line, depends on two components: a means of collecting the ambient light and a method of forming images. While humans rely on a cornea and lens to focus an image on the retina, fish lack a cornea because it would be essentially useless underwater. Pelagic fish must rely solely on a lens to focus the light into clear images. The spherical-shaped lens is moved in and out, similar to a camera's zoom lens, in contrast to the stretching that occurs with the human lens, to produce a sharp image.

A fundamental measure of visual capacity is sensitivity: the minimum amount of light that enters the eye and produces a behavioral response in the organism. Unlike terrestrial vertebrates, fish have no anatomical means to dilate or contract their pupils in response to changing light conditions. Light intensity in the ocean is essentially a function of depth—the greater the depth, the less ambient light. At approximately six hundred feet in the open ocean, the light intensity is only 1 percent of that at the surface.

Pelagic species differ in their ability to detect objects in low-light intensities. Dolphin (mahi mahi), for example, generally feed in the upper sunlit layers of the ocean, generally during the day. Their vertical range and thus their forage capabilities are controlled by the availability of light. In contrast, the optical sensitivity of a marlin's larger eye is higher because of the large number of light receptors it contains. The marlin's eye is specifically adapted to cope with low light levels encountered during a dive, increasing its feeding range.

In their study of the swimming speeds and depths of captured and then released blue marlin, Barbara Block and her associates documented that during the daylight hours, these fish usually spent most of their time near the surface but periodically made short dives of to two hundred to three hundred feet. Even during the night, the marlin

made numerous soundings, probably all in response to feeding. (There was no mention in the report if there was any available moonlight during the marlins' nocturnal excursions.)

While contemporary anglers troll baits and lures near the surface, taking advantage of the blue marlin's propensity to swim near the surface, Hemingway repeatedly chronicled setting his baits deep down (over one hundred fathoms, or six hundred feet) when targeting marlin. Even in *The Old Man and the Sea*, Hemingway describes Santiago deploying his baits: "One was down forty fathoms. The second was seventy-five and the third and fourth were down in the blue water at one hundred and one hundred and twenty-five fathoms." What are we to make or believe of Hemingway's writings of marlin hunkering in the abyss? Assuredly, he caught many big marlin as shown in the myriad photographs of Hemingway and his catches. But were these fish caught at one hundred fathoms or more? At these depths, light intensity is at a minimum, and marlin, even with their high optical sensitivity, would have difficulty in visually detecting prey. Even more troubling is that the water around Cuba has a pronounced semipermanent thermocline, which cold-blooded marlin rarely enter. The difference in temperature between water in the warm surface layer and water at one hundred fathoms approaches twenty degrees. While it may be argued that environmental factors certainly limit the foraging range of the blue marlin and thus cast into doubt Hemingway's deep-fishing accounts, an additional bit of evidence can be gleaned from a closer reading of *The Old Man and the Sea*.

Hemingway writes that Santiago was fastidious in setting out his baits: "He looked down into the water and watched the lines that went straight down into the dark of the water. He kept them straighter than anyone did, so that at each level in the darkness of the stream there would be a bait waiting exactly where he wished it to be for any fish that swam there." But did the lines hang perfectly vertical and at their proper depths? The strong current that runs along the northern coast of Cuba is not confined to the surface but extends hundreds of feet below the surface. This subsurface flow would easily deflect the line, which at least in Santiago's case was "as thick around as a big pencil," and the attached bait. Even Hemingway acknowledges this possibility: "Others let them drift with the current and sometimes they were at

sixty fathoms when the fishermen thought they were at a hundred." But Hemingway argues that Santiago was more diligent than other Cubans in his fishing practice: he "rowed gently to keep the lines straight up and down." How could Santiago, or even Hemingway on his fishing outings, determine whether the lines were truly hanging vertical as they plunge hundreds of feet below the surface? Even a small deviation, measured in degrees, from the vertical could mean a marked displacement of the line and bait from its intended position.

The question remains, given adequate light, what is the visual acuity of a pelagic fish? Can it resolve the smallest detail of an object? Can it "discriminate" between food and nonfood items? Though numerous methods exist to measure visual acuity, the most prevalent is to determine the minimum angular size of standardized letters that can be identified—"reading the eye chart." If "normal" human vision is 20/20, then, for comparison, the visual acuity of dogs is 20/50 and in marlin 20/90, making them nearsighted. To put that in perspective, marlin are able to resolve a four-inch object from a distance of 150 feet under optimal light conditions. If two similar objects are in close proximity to each other, the marlin may not be able to distinguish between them if they are off in the distance.

Can marlin also distinguish colors? This question has generated considerable interest within the scientific community and has also captivated big-game anglers who routinely fill their tackle boxes with colorful lures. While direct color discrimination experiments are virtually impossible to undertake with large fish in the open ocean, anatomical evidence strongly supports the existence of color receptors in the eyes of these fish. Our eyes are sensitive to a wide spectrum of colors, ranging from violet to red, but the most abundant pigments found in the photoreceptors of marlin are blue-green. These pigments are perfectly matched to the prevailing light that filters down into the clear ocean water. As sunlight penetrates the water, colors are selectively absorbed, the first being red, then orange, and so on until the last color, blue, is lost. At depth, organisms appear to be cloaked in a blue blanket. While a bright red lure may generate significant appeal as the "hot" lure of the day to a boat's crew, it may elicit little interest from a billfish since it is essentially color-blind in the red end of the light spectrum.

A marlin that is excited, showing keen interest in a particular food item, may markedly change color. It may become, as referred to by anglers, "lit up"—the blue bars along its flanks dramatically increase in intensity and contrast. This explosion of color also contains a strong ultraviolet component, as revealed by spectrophotometric measurements. But the fish's lenses block ultraviolet light, rendering it blind to this component of its own body color. If a marlin cannot see the ultraviolet portion of the spectrum, why does it make this display a prominent part of its light show? One hypothesis is that this conspicuous coloration may have a disruptive effect on a school of prey: confusing it, causing a breakdown in the school's tight-knit structure. And at least two species that prey on billfish have lenses transmitting light in the ultraviolet waveband and are likely to perceive a large fraction of the ultraviolet peak found in the blue bar of the fish.

Good Vibrations

If light conditions are far from optimal or marlin are not picking up visual cues, they may rely on mechanical perception, sensitivity to vibrations in the water, for finding prey. The ocean is far from silent; it buzzes with all types of sounds, from the subtle clicks, snaps, and crackles of tiny organisms to the thunderous explosion of a predator breaching the surface in pursuit of prey. When animals move through the water, they produce sound waves that can be detected and interpreted by other animals. Since sound travels quickly in water—five times faster than in air—the ocean is like an early warning system for the approach of prey and predator.

For a predator, its sensory systems, an inner ear and the lateral line, must filter out extraneous noise and yet pick up "good" vibrations that it can process and interpret as a potential meal. A frightened prey that is attempting to flee produces a complicated series of body movements, which are presumably detectable by a predator several yards away. The billfish may detect and evaluate the origin of such vibrations by swimming through them or by perceiving them as auditory cues as they are swept past in the flow of a current.

The fishing tackle industry has invested considerable sums of money in developing trolling lures that produce particular sounds that it

believes would be attractive to billfish. Blue marlin are by nature quite aggressive and respond well to the sounds emitted by a well-presented artificial lure. Artificial-lure fishing for billfish, which has gained in popularity over the years, originated in Hawaii, where the earliest lures were carved from wood or cast in drink glasses, or even made from bath towel dowels. Each lure was adorned with either rubber inner tubes or vinyl upholstery material, both cut into long strips.

Today, marlin lures come in a variety of shapes, sizes, and colors. These lures range in size from small (seven to eight inches) to large (fourteen inches or more) and have a shaped plastic or metal head to which a plastic skirt is attached.

The lure's head, particularly its front part, can come in a variety of shapes—bullet, conical, and concave—each designed to create a particular individual action, such as a bubbly wake, a popping noise, or side-to-side swimming pattern, when trolled through the water. In addition to the dimensions and shape of the lure, the length and thickness of the skirting, the number and size of hooks, and the nature of the leader used in rigging all have an effect on the action of the lure and hence its overall appeal to a marlin. Savvy anglers fine-tune their lures to get the desired action under different sea conditions or trolling speeds.

Even the drone of a diesel engine, the pressure wave from the bow of the boat, or the pounding of the boat's hull through the water may generate distinctive sound frequencies that, like a dinner bell, call the fish to eat. Curious about the nature and source of the sound, a marlin may rise to the surface to investigate the commotion. Attracting or "raising" a marlin into the trolling spread is what all big-game anglers aim for—the first step in a potential successful outing.

But raising a marlin is not catching it, nor is it even hooking it. In some cases, the proportion of marlin hooked is relatively low compared with those that are lured to the surface. (Noted marlin angler Peter Wright considers it a productive fishing outing when he raises twenty fish and catches five—a 25 percent success rate.) Does the marlin reject the offering because upon closer inspection the visual or auditory signals from the target (bait/lure) may seem askew, not natural, to it? Or is it just curious, playful, but not hungry enough to feed? (Recall that Hemingway observed and documented various modes of marlin behavior, some of which were maddeningly frustrating to him, during his

numerous fishing excursions.) Recognizing that marlin may be indifferent to the food offering, most anglers are content if their efforts lead to a success rate of one to two caught for every dozen enticed to the surface. The ocean is often reluctant to release its prized inhabitant.

Blue Marlin–Angling Destinations

In spite of these low odds, or maybe because blue marlin are such a challenge, anglers routinely travel throughout the tropical and subtropical Atlantic in the hope of tangling with the ultimate billfish. But particular angling destinations stand out because of the number and/or size of marlin that congregate at these sites. While the abundance of prey is a necessary criterion for attracting marlin, it alone is not sufficient. As true pelagic species, blue marlin prefer locales that are in close proximity to deep blue water. These can include in many cases open ocean islands, generally volcanic in nature, underwater promontories, and sharp drop-offs at the edge of the continental shelf.

AZORES: This archipelago of nine volcanic islands, born from the fiery extrusions of a restless earth, is located almost one thousand miles east of Portugal and is the northern extreme of the blue marlin distribution. While these outposts in the Atlantic are surrounded by water in excess of three thousand feet deep, the most productive fishing sites are the Condor Bank, the Azores Bank, and the north coast off the island of Faial. These fertile grounds are dotted with seamounts (undersea volcanoes), which deflect nutrient-laden bottom currents up to the surface. These Azorean waters are home to large blue marlin with the average weight of this species, at 500 pounds, but larger specimens (800 to 1,200 pounds) are frequently encountered as well. This blue marlin fishery involves trolling large artificial lures, and the season begins in June and runs through the summer due to the presence of the Bermuda-Azores high pressure center that results in fair weather and calm seas.

BAHAMAS: This cluster of islands has been a popular destination of marlin anglers, including Ernest Hemingway, Michael Lerner, and S. Kip Farrington, since the 1930s. In particular, the island of Bimini, ideally located along the eastern edge of the Gulf Stream, has the longest

history of marlin fishing in the Bahamas. By the late 1960s, more outlying sites, such as Walker's Cay, the northernmost island in the Bahamas, developed into marlin fishing grounds due to their close proximity to deep water.

BERMUDA: Since this isolated island is in the path of migrating game fish, it has a productive marlin fishery, particularly during the summer months. While most marlin specimens are small, in the 150–250 pound range, the fertile waters surrounding the island offer up much bigger fish, 600 pounds and larger, every year. But in 1995 a 1,352-pound giant, which still stands as the largest blue marlin caught in Bermuda water, was boated by the crew of the *MAKO 4*, a Bermuda charter boat.

BRAZIL: Though Brazil has a five-thousand-mile coastline that is bathed in warm water from the southward-flowing Brazil Current, the majority of blue marlin destinations are well south of the Amazon River, whose prodigious flow results in sediment-laden water being carried many miles out to sea. Blue-water anglers would best concentrate their efforts on the eight-hundred-mile stretch between the cities of Salvador and Rio de Janeiro. In particular, those anglers yearning to catch the marlin of a lifetime should use the small town of Canavieiras, about 170 miles south of Salvador, as their starting point. Approximately seventeen miles from this marlin mecca lies the Royal Charlotte Bank, a fishing ground that has proven year after year to be a world-class blue marlin fishery. The bank runs fifty-five miles to the east and intercepts the Brazil Current on its northern edge, resulting in the upwelling of nutrient-rich water that attracts baitfish and game fish alike.

CANARY ISLANDS: These islands are a Spanish archipelago, located just off the northwest coast of mainland Africa. As with the Azores, the islands are surrounded by seamounts, which rise thousands of feet from the ocean floor and support a variety of marine life that attracts blue marlin. In particular, the waters near the island of La Gomera are abundant with baitfish, and blue marlins in excess of 1,200 pounds have been caught there.

CAPE VERDE ISLANDS: This destination is an oasis for marlin anglers, who travel here to tackle big marlin that have often made the long journey across the Atlantic. Farther south than either the Azores or Canary

Islands, these islands have a long fishing season, but the best fishing appears to occur relatively early, March to May, when large numbers of marlin take up residence in the islands' waters.

CAROLINAS: The offshore waters off the South and North Carolina coasts can be prime blue marlin fishing grounds due to a host of interlocking conditions: proximity of the Gulf Stream, underwater structures such as the Charleston Bump and the Big Rock, and deep, blue water at the edge of the continental shelf. While the marlin generally run smaller (250 to 400 pounds) than ones found in other destinations, hooking up with a true behemoth when trolling ballyhoo or larger bait is not out of the question.

MADEIRA: Close proximity to deep water makes the Portuguese island of Madeira home to some of the biggest blue marlin that are caught throughout the Atlantic. Like its cousins—Azores, Canaries, and Verdes—Madeira is an extinct volcanic island, surrounded by fertile water that has upwelled from the depths. Fishing season generally runs from June to September, when seasonal warming of the waters counters the influence of the cold Canary Current.

6

Night Stalkers

SWORDFISH

Dominating the entrance to the fishing museum of the International Game Fishing Association in Dania, Florida, is a larger-than-life sculpture of a leaping swordfish, suspended in air as if defying gravity and rebellious in nature with its bill thrust skyward. Soaring twenty-four feet in the air, this stainless steel sculpture by Ken Ullberg is just one dramatic example of the myriad artistic expressions that attempt to capture the essence of the iconic billfish.

Of all the thousands of fish species that roam the earth's oceans and seas, probably none has garnered the imagination and interest of sculptors, painters, and illustrators more than that of the billfish. From jewelry to statues to paintings, artists have employed a number of media to show the power, beauty, and grace of these fish. In addition, many countries, including Cuba, Antigua, and Grenada, have showcased billfish, particularly the sailfish, on their postage stamps. Even the ubiquitous T-shirt has become a canvas for displaying billfish in action—breaching the water in pursuit of prey or cruising along a sargassum weed line.

As to be expected, various artists have approached their subject from different angles. Guy Harvey, for example, is also a scientist, having received a doctorate in fisheries biology from the University of West Indies, who uses his training to better understand the habits of the billfish that he paints. Not afraid to be part of the billfish's element, Harvey routinely dives into the water to photograph these fish in their natural surroundings. And as an avid angler, Harvey tries to convey the excitement of fighting a billfish through his artistic output.

In contrast, Duane Raver, a noted North Carolina artist, has been painting and drawing wildlife for over seventy years without any formal

training, but as he relates, "just a lot of trial and error over the years." His efforts have certainly paid off, as his exquisite fish illustrations can be found in numerous books, including this one, and other venues. While Raver would prefer to work with live models, most of the time that has not been practical, and instead he has relied on a combination of well-preserved specimens, sketches, photographs, and copious notes, some of which date back to the 1940s. When asked which billfish he enjoyed painting the most, he demurred, ultimately giving a slight nod to the blue marlin. While he has painted all Atlantic billfish with equal diligence, Raver rates the sailfish as the most difficult to depict because of its subtle shading.

When does adding a billfish painting or sculpture to your collection of fishing memorabilia seem inadequate? How about when you catch that fish of a lifetime? Many anglers turn to a taxidermist to create a fish mount, an accurate replica of the subject with regard to size, anatomy, and coloration. Many early fish mounts were made using the actual specimen and were commonly referred to as "skin mounts," but with the practice of catch and release receiving wide acceptance within the angling community over the years, most saltwater fish are re-created using fiberglass molds. These synthetic mounts, known as release mounts, have proved to be far superior to skin mounts in durability and anatomical perfection. A swordfish angler, for example, needs only to provide to the taxidermist the length of his or her catch and a photograph—nuances in coloration can be addressed by the artist—to start the process of producing an accurate replica of a prized fish.

Swordfish Haunts

Though the swordfish (*Xiphias gladius*) occupies its own branch (Xiphidae family) on the Scombridae tree of life and is a single species worldwide, it shares many of the same morphological characteristics of its closest relatives: a fusiform body tapering to a slender caudal peduncle, a long, pointed bill, and a pronounced lunate caudal fin. But the swordfish's dorsal fin is of itself enough to distinguish the fish at first glance from other billfish. This high, rigid fin has a deeply concave rear margin and is short in length, as compared to the elongated dorsal fins

PHOTO 11. Swordfish. Note the large eye. Copyright Shuttlestock.com / Mikel Dray.

in other billfish. The color of a swordfish is also distinctively different than its fellow gladiators: blackish-brown above, shading to a lighter color below. Its body also lacks the faint vertical stripes found on sailfish and marlin. But it's the swordfish's eye that catches your attention. A black, tennis ball–sized orb stares back, mesmerizing you. As one old-time swordfisherman related, the eye "fixes you," rendering you useless to throw the harpoon into the fish.

The swordfish roams the oceanic regions worldwide, including the Atlantic, Pacific, and Indian oceans. Though primarily a warm-water species, the swordfish has the widest temperature tolerance of any billfish, which allows it to range from tropical waters to, at times, cold, high-latitude waters. A prodigious traveler, Atlantic swordfish spawn in the Caribbean Sea, the Gulf of Mexico, and Florida waters and then travel, swimming either alone or in loose aggregations, northward during the summer months to the waters off of Massachusetts and Newfoundland. Two particular areas stand out with regard to the congregation of

migrating swordfish: the Georges Bank and the Grand Banks. The former lies eastward of Cape Cod and the shallow Nantucket Shoals and is considered by geologists to be an extension of the latter due to their similarities in depth. The Grand Banks is a compilation of underwater plateaus found on the broad continental shelf off of Canada.

The arrival of swordfish to these banks coincides with the presence of vast schools of prey, such as herring. These shallow submarine plateaus are biologically quite productive, supporting an abundance of marine species. These prey-rich waters owe their existence to the confluence of the cold, nutrient-laden Labrador Current, which sweeps south over the banks, and the warmer Gulf Stream. The mingling of the two currents, in conjunction with sunlight penetrating the shallow waters, fosters an ideal setting for the explosive bloom of phytoplankton, setting in motion the beginnings of a food chain. Swordfish will feed in these northern waters until cooling water temperatures provide the impetus to return to southern climes.

Spawning, which can occur year round in the western tropical Atlantic, involves the solitary pairing of a male and a larger, highly fecund (millions of eggs per spawn) female, who broadcasts her buoyant eggs in the surface waters. Embryonic development occurs during the three days following fertilization, and the resulting pelagic larvae are less than an eighth of an inch upon hatching. For those larvae that survive predation, growth is fast and appearance changes markedly: from a youngster with a relatively short snout, scaly body, and teeth to a mature adult with a characteristic long upper bill and a smooth, streamlined body.

In the Mediterranean Sea, the major spawning grounds are off the southern parts of Italy and Sicily, with the highest swordfish concentrations occurring in the Strait of Messina. Adults are present in these waters in all months except January and February, and spawning is most intensive from the end of June to August, when males are often seen pursuing females. Although the swordfish is capable of long-distance migrations, the populations in the western Atlantic and the Mediterranean are viewed as separate and distinct groups, with little, if any, intermingling occurring between them.

Swordfish of all ages are opportunistic predators, feeding when and where food is available, but are restricted by their size to what

they can consume. Larval swordfish feed primarily on zooplankton and other fish larvae, and juveniles consume squid, small fish, and pelagic crustacean. Adult swordfish forage on a variety of fish as well as squid and other cephalopods. Captain Benjamin Ashby, a swordfisherman for over twenty years during the nineteenth century, reported seeing swordfish feeding on mackerel, herring, whiting, and menhaden, and he claimed to have found half a bucket of these small fish in the stomach of a swordfish. He further noted that he was startled to observe firsthand a swordfish propel itself out of the water through a dense school of herring, fall flat on its side, and slash its helpless victims with its sword. Regaining his composure, Ashby was able to retrieve as much as a bushel of herring, the remains of the swordfish's onslaught. No need to let go to waste perfectly good fish, he rationalized.

By the time swordfish reach maturity, they are searching the water column for food. As an old fisherman once said, "They rise when the mackerel rise, and when the mackerel go down, they go down also." But a recent study by Heidi Dewar of the Southwest Fisheries Science Center in La Jolla, California, and her colleagues has added more detail to our understanding of swordfish's movement. Swordfish from the eastern Pacific, central Pacific, and western North Atlantic–Caribbean all exhibited similar diving patterns over a three to four day period: residing below the thermocline during the day and inhabiting the warmer surface layer during the night.

During the daylight hours, swordfish probe the depths, working their way down the water column in search of surface to midwater fish, such as bluefish, mackerel, menhaden, and herring, to deep dwellers, including hake and squid. Studies of their dietary preferences date back years: a swordfish caught off the Georges Bank in 1916 was full of silver hake; one taken in 1929 contained five bottom-dwelling haddock; and another contained a squid and fragments of a silver hake. As reported by George Brown Goode, a nineteenth-century ichthyologist and museum administrator at Smithsonian Institute, it was not out of the ordinary for swordfish to be hooked on deep lines set for halibut, including one case when thirteen swordfish were caught in this manner on one halibut trip. A more recent study found the majority of large

fish consumed by the swordfish have been slashed by its formidable bill, while small prey have been swallowed whole since adults lack teeth for grasping or cutting.

To adapt to the low light conditions and cold temperatures encountered on excursions into the abyss, swordfish have a highly specialized heating system that warms the blood traveling to the eyes and brain, while the rest of the body has a temperature similar to that of the environment. Rather than simply conserving heat that is produced in the tissues—a trait found in endothermic species, such as bluefin tuna and mako sharks—swordfish produce heat. The swordfish can control the amount of heat produced by its internal furnace—pumping out more heat while swimming in cold waters and dialing down the thermostat in warm water.

On deep dives during which water temperatures may change from a balmy 75°F at the surface to a bone-chilling 45°F at two thousand feet, the swordfish's brain temperature may be elevated significantly above the ambient water, thus minimizing rapid fluctuations in brain temperature that can impair behavior or, at the extreme end, lead to death. The warming of the brain allows swordfish to break through thermal barriers, which are obstacles to the movement of other billfish, such as white marlin, which spend most of their time in the warm surface layer.

The ocular heating endows these hunters with superior vision compared to other pelagic predators. In particular, natural selection has favored the conversion of a muscle in the eye once used for movement—superior rectus—into an organ generating heat, which elevates the eye temperature to more than ten degrees warmer than the surrounding water. To maintain this heat and minimize its loss to the surrounding water, a complex of fine, parallel arteries and veins—*reta mirabile* (Latin for "wonderful net")—provides for a countercurrent heat exchanger.

Researchers at the University of Queensland, led by Kerstin Fritsches, have shown that the swordfish's warm eyes are ten times faster in registering flickers of light than eyes kept at deepwater ocean temperatures. Such high temporal resolution is analogous to a camera's high shutter speed, aiding in the swordfish's ability to detect and capture quick-moving prey especially in dim light. Warm eyes, then, should provide the swordfish a critical advantage over its deep-dwelling prey. And because squid and other fish lack the means to keep their eyes warm, they may

not be able to see clearly a swordfish streaking out of the gloom. In Neptune's realm, the warm-eyed swordfish reigns supreme.

As dusk approaches, swordfish ascend from the depths, rising to surface and near-surface waters. This vertical migration is in response to the movement of prey on which the swordfish feed. Each evening as the sun sets over the Atlantic, millions of zooplankton slowly ascend from depths of fifteen hundred feet or more to feast on the microscopic plants residing in the surface layer. The zooplankton will feed throughout the night, but with the approach of daylight, they reverse course, sinking slowly to reside in the darkness during the day. Biologists have known about this vampirelike behavior since the late 1800s because their nighttime samples had a greater abundance than during the day. But the exact nature of this en masse movement of tiny creatures wasn't deciphered until World War II when the U.S. Navy was testing its submarine-detecting sonar equipment. Shipboard personnel were puzzled by a sound-reflecting layer that was appearing on numerous recordings but was too shallow to be the bottom. Initially, they referred to this strong reflecting surface as a "false bottom," but upon further analysis, they changed the name to the "deep scattering layer"—a densely packed layer of organisms that appears to be a solid surface hanging in midwater. Biologist Deborah Steinberg and her colleagues, who have systemically studied the deep scattering layer over the years, compare the daily migration of the layer's tiny organisms, which travel tens of thousands of body lengths every day, to a person walking twenty-five miles to get back and forth to his or her next meal.

But even under the cover of darkness, predators find their way to the deep scattering layer. Zooplankton often feed on bioluminescent dinoflagellates, microscopic phytoplankton, which are capable of producing light from a chemical reaction within specialized cellular structures. When dinoflagellates are disturbed by grazing zooplankton, they emit a flash of light, lasting a few tenths of a second. Like a moth drawn to a flame, predatory species, such as squid, are drawn to this flash and feed voraciously on the zooplankton. And soon to partake of this nocturnal buffet will be the swordfish.

One exception to the swordfish's vertical migration pattern is its periodic basking at the surface during the day. Why would a highly specialized, top-level predator spend time lounging around? The

consensus answer centers around two issues: metabolism and internal body temperature.

One category of metabolism is digestion—the breakdown of foods into smaller components that can be absorbed into the blood. As with many biological processes, digestion rates are a function of temperature. A swordfish, for example, in 42°F water has a digestion rate that is approximately three times slower than in 68°F water. A swordfish that has been gorging itself at depth may opt to bask in the warm surface waters to speed up digestion.

While at depths, swordfish can conserve some body heat, but not to the extent found in tuna, for example. Over time, the swordfish's core body temperature decreases, resulting in sluggish behavior due to a marked decrease in muscle contractions. The swordfish must come up from the cold to warm itself.

The tendency for swordfish to bask, with its dorsal and caudal fins clearly visible, in calm, surface waters has made them an easy target for fishermen, wielding a variety of spears and lances to be thrust into the unsuspecting animal. Fishermen have harpooned swordfish for thousands of years, a practice that originated in the Mediterranean region.

Swordfish: A Hunted Animal

Archeological evidence, including barbed harpoon heads and preserved swordfish remains uncovered from a number of sites in Maine and the Canadian Maritimes, has documented that aboriginal swordfish hunting was quite prevalent during the Late Archaic period, 5,000 to 3,800 years ago, in the Gulf of Maine. But lacking in the thorough excavation of the sites was any record of the boats that were used for such treacherous ocean hunting. David Sanger, a University of Maine anthropologist, has argued that birchbark canoes, the traditional mode of transportation for the native people, were quite seaworthy to withstand the rigors of the open water environment. While Sanger may have explained the logistics of aboriginal swordfish hunting, his continued work in this area led to a disconcerting finding: why was the practice of swordfish hunting abandoned around 3,800 years ago? One hypothesis is that there was a significant change in the swordfish's range,

precipitated by cooling sea surface temperatures. Though Sanger was not able to gather any strong paleo-oceanographic data on the Gulf of Maine supporting climatic cooling, today, as documented by oceanographers, the Eastern Maine Coastal Current, flowing from the Bay of Fundy south to Penobscot Bay, is too cold to support a harpoon fishery. Swordfish prefer to bask in 60°F water and have access to an abundant food supply, such as on the east side of the Georges Bank. The fact that so many swordfish relics, such as bills and skeletal fragments, and artifacts made from bills have been found along the coast is at least anecdotal evidence that the range of swordfish thousands of years ago was greater than at present. But ever the skeptic, Sanger has argued that the demise of swordfishing 3,800 years ago marks the beginning of a culture shift for the indigenous population, when a new way of life was introduced during the Susquehanna period by inhabitants of the Chesapeake Bay region. While the exact cause of the end of subsistence swordfishing in Maine is still unresolved, Sanger's interdisciplinary investigation opened a new chapter on ancient swordfishing endeavors. (Other old harpoon fisheries for swordfish included western North America about two thousand years ago, western South America since at least the 1600s, and Japan for several centuries.)

By the mid-eighteenth century, places like Martha's Vineyard, Barnstable, New Bedford, and Nantucket became major seaports, supporting the flourishing industry of whaling. Of the crew who manned the ships that plied the New England waters and beyond in search of right and sperm whales, probably none rivaled the captain in stature except the harpooner, many of them immigrants from the Cape Verdes and Azores. Having honed their skills in their home waters, these hard-working men were eager to sign on to any American ship, often to escape military service in their native lands. Queequeg, the tattooed harpooner aboard Captain Ahab's *Pequod*, is said to have originally been an inhabitant of the South Seas.

But by the mid-1800s another group of industrious New Englanders, many of them recent arrivals to the shores of America, were searching for their own "white whale"—the swordfish. Let us again turn to George Brown Goode for his account of how these men subdued their quarry. "The apparatus ordinarily employed for the capture of the swordfish

is simple in the extreme. It is the harpoon with the detachable head. When the fish is struck, the head of the harpoon remains in the body of the fish and carries with it a light rope which is either made fast or held by a man in a small boat, or is attached to some kind of buoy, which is towed through the water by the struggling fish, and which marks its death." Rewind some five thousand years ago—a time of the first swordfish hunters from Maine. Barbed harpoon heads, some with gouged holes for the retrieving line, were uncovered in numerous archeological sites in Maine. The lines could have been made of leather or plants, and attached to the line was probably a float, possibly made of inflated sealskin. Sounds familiar? These findings clearly resemble the technology employed by nineteenth-century swordfishermen. While Goode could not, with confidence, address the similarity of hunting methods separated by thousands of years, he is quite detailed in the description of the harpoon employed by the New Englanders:

> The harpoon consists of a pole fifteen or sixteen feet in length, usually hickory or some other hard wood, upon which the bark has been left, so that the harpooner may have a firmer hand-grip. The pole is from an inch and a half to two inches in diameter, and at one end is provided with an iron rod, or "shank," about two feet long and five-eighths of an inch in diameter. Upon the end of the shank fits the head of the harpoon, known by the names swordfish-iron, lily-iron, and Indian dart. When the iron has once been thrust point first through some solid substance, such as the side of the fish, and is released upon the other side by the withdrawal of the pole from the socket, it is free, and at once turns its long axis at right angle to the direction in which the harpoon-line is pulling, and this is absolutely prevented from withdrawal.

The harpooner was always positioned at the end of the bowsprit of a sailing vessel, such as a schooner, which over time became appropriately referred to as a swordfish "stick" boat. The ship was equipped with a "pulpit," for the support of the harpooner as the vessel plowed and plunged into rolling seas. From this raised platform, the harpooner would have domain over the creatures he sought.

The search for swordfish was aided by another crew member stationed on the masthead, where, with the keen eyes that practice had given him, he was capable of sighting the telltale dorsal fin of a basking swordfish more than two or three miles in the distance. Upon a sighting,

the watch, from his precarious position, sung out, alerting the captain to steer the vessel to it. Surprisingly, as Goode pointed out, "there is no difficulty in approaching the fish with a large vessel, although they will not suffer a small boat to come near them."

Goode described the action unfurling as the moment of confrontation between crew and fish drew near.

> Although there would be no difficulty in bringing the end of a bowsprit directly over the fish, a skillful harpooner never waits for this. When the fish is from six to ten feet in front of the vessel it is struck. The harpoon is never thrown, the pole being too long. The strong arm of the harpooner punches the dart into the back of the fish . . . When the dart has been fastened to the fish the line is allowed to run out as far as the fish will carry it, and is then passed into a small boat. Two men jump into this, and pull in upon the line until the fish is brought alongside; it is then killed with a whale-lance, which is stuck into the gills.

Throughout the latter part of the nineteenth century, the harpoon fishery off of New England grew and flourished, and by the early 1900s, the fishery expanded to Nova Scotia, Canada. This increase in growth is rather surprising since, while swordfish is now prized as a food item, it was virtually unsalable in Boston during the 1980s and commanded only a very low price in New York. In 1929, fishermen could fetch about twenty cents per pound, and by 1947, the price had only risen to forty cents.

John Josselyn, a seventeenth-century Englishman, wrote with credulity about what he had seen and heard during his travels to New England. In his book *An Account of Two Voyages to New-England*, he remarks, "The small swordfish is very good meat." The consensus among some historians is that Josselyn probably never even came upon a swordfish, never mind ate one, in his wanderings but obtained the information secondhand. Regardless, the white flesh of the swordfish is indeed tasty, with a mild and sweet flavor, and yet possesses an underlying richness enhanced by the flesh's fat content.

But while financial gain may have been the primary motivating force to risk life and limb in the pursuit of swordfish, fishermen at their core are a roguish lot. Since the beginning of time when people first went down to the sea, adventure has lured them to this briny realm. Zane Grey captured the essence of swordfishing in his short story "Swordfish,"

which was ultimately published in *Tales of Fishes*: "The pursuit of the swordfish is much more exciting than ordinary fishing, for it resembles the hunting of large animals upon land and partakes of more of the nature of the chase . . . The game is seen and followed, and outwitted by wary tactics, and killed by strength of arm and skill." An old swordfisherman who had followed his calling for over twenty years told Grey that even in his dreams he stalked the swordfish, and "that many a time he had rubbed the skin off his knuckles by striking them against the ceiling of his bunk when he raised his arms to thrust the harpoon into visionary monster swordfishes."

Even today, people, with harpoon in hand, are still drawn to the pursuit of swordfish. Though their numbers have dwindled considerably since the nineteenth century, a hardy band of New England fishermen still use methods employed by their ancestors. Fast, diesel-powered boats have replaced lumbering sailing vessels; spotter planes now soar over the crow's nest; but the harpoon remains. The demise of the harpoon fishery throughout the world owes its fate to more efficient fishing methods; ironically, the Mediterranean, the birthplace of this fishery, now hosts only a token number of harpoon boats.

Since the 1960s, commercial swordfishermen have relied on pelagic longlining, a technique that appears to have been originally developed by the Japanese as early as the mid-nineteenth century. At its core, longlining involves hanging a thousand baited hooks from a monofilament mainline that may stretch forty miles behind the boat.

As the night washes over the fishing grounds, the crew starts the laborious task of setting out the line, which may take four hours or more to complete. The mainline, which is spooled on a large drum, is fed back to the stern of the boat, where a crew member impales the bait—squid or mackerel—on a circle hook that is at one end of a forty-foot branchline. At the other end is a stainless snap, which attaches to the mainline. And to complete the setup, a luminescent light stick is fastened about six feet above the baited hook, illuminating it and also attracting prey species. As the boat motors forward, the branchlines are suspended at intervals of 250 to 350 feet along the mainline. After every three or four hooks, a crew member snaps a buoy onto the mainline, which keeps it floating in the water column at a depth of twenty to thirty feet

PHOTO 12. Swordfish hunting from harpoon boat. Copyright Istockphoto.com / Gaspare Messina.

below the surface. A typical setup, from buoy to hook, may hang sixty to seventy feet down, well within the zone of the nocturnal-feeding swordfish. Every four miles or so, a buoy is replaced with a high-flyer, a float and aluminum pole that has a highly radar-reflective surface on top, which provides visual cues on radar screens to other boats in the area. And finally a radio beeper marks the end of the longline.

Swordfish sets are as much a science as a technological challenge. Many a swordfish trip has gone bust because the captain has made the wrong choice as to where to deploy the gear. Along the Grand Banks, for example, baits are routinely deployed between the confluence of cold and warm currents. Food items, such as herring and squid, feast on cold-water plankton, and swordfish dart out from filaments of the warm Gulf Stream water to capture prey. Warm core rings that spin off from the Gulf Stream into the North Atlantic trap tropical species, which may provide nourishment for swordfish.

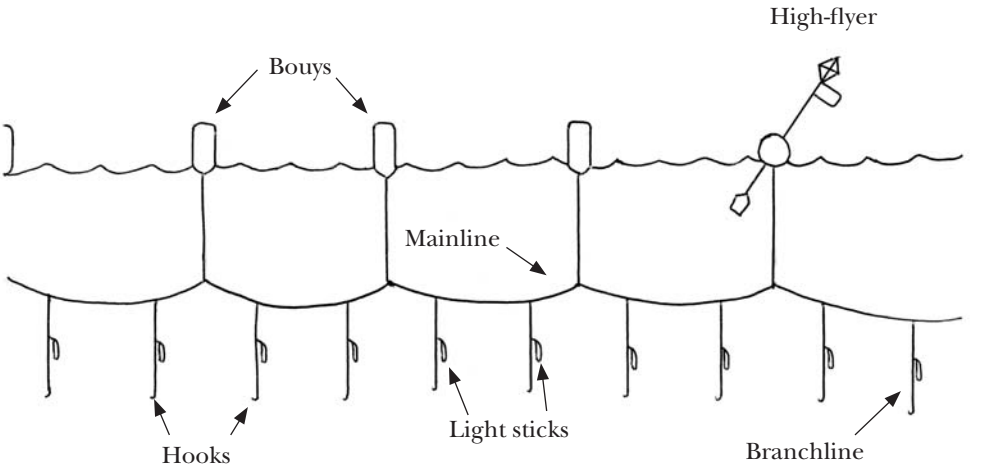


FIG. 8. Longline gear. Courtesy of Rebecca Bunker.

After a predetermined "soak time" for the bait, the gear is retrieved by means of hydraulics. Anxious crew members intently watch as the mainline comes onboard; empty hooks bring only a slight nod, an acknowledgment to the fickle nature of fishing. But a distinctive heaviness to the line heightens the senses. Any big fish that is still alive is dangerous. A puncture wound by a swordfish's bill, with the boat many miles from shore and medical attention, can be disastrous. When the fish is alongside the boat, two crew members swing gaffs into its sides to control it, and they may even harpoon it if the fish is particularly unruly. Once subdued and onboard, this gladiator of the sea meets its final fate: its head and tail are sawn off; it's gutted; and it's dumped on ice in the hold. On a good day, one set might yield ten to twenty swordfish, equating to a ton of meat. And to each crew member, every swordfish means money in his pockets; even the lowest guy on the totem pole may make thousands of dollars on a single trip.

Since the inception of longlining in the North Atlantic, swordfish landings skyrocketed, increasing more than 1,500 percent over a thirty-year

period. A similar trend was also occurring in the Mediterranean and the South Atlantic. Longliners were pursuing swordfish throughout their range; there was money to be made. And the ships came from near and far: United States, Canada, Spain, Portugal, Brazil, Taiwan, and Japan.

In the United States alone, the swordfish fleet had bloomed by the mid-1980s to over seven hundred vessels, fishing over 50 million hooks a year. The exponential rise in the number of vessels was fueled, in part, by a condition, known to resource managers, as open access—where the access to the fishery, for the purpose of harvesting fish, is unrestricted; that is, the right to catch fish is free and open to all.

Protection for a Threatened Species

But this explosive growth in a fishery was unsustainable; high-tech fishing methods were butting up against a finite resource. Many inside and outside the fishery refused to acknowledge, or even believe, there was a potential problem looming on the horizon. What led to such behavior? Its origin may date back to the late 1950s, when the prevalent thinking, even among some respected fisheries' biologists, was that the sea and its creatures were boundless in their abundance. (A Woods Hole Oceanographic official and his coauthor, a curator at the American Museum of Natural History, confidently entitled their book *The Inexhaustible Sea.*)

A rude awakening occurred in the early 1960s with the arrival of a new kind of fishing vessel. It was big—much bigger in length and tonnage than any ship that preceded it; it fished huge nets from the stern; and it quickly processed and froze all the fish it caught. Known as a factory trawler, its operations were continuous, around the clock, and relentless, sweeping the ocean floor clear of species like cod and haddock. Fish numbers plummeted, and fishermen, legislators, and biologists had to acknowledge that, indeed, fish populations could be depleted. Even more rankling to many U.S. flag wavers was that many of these factory ships were Russian built and operated, fished almost within sight of land, and caught "our" fish. Congress was pressured into action, and in 1976 they passed the Magnuson Fishery and

Conservation Act, which barred international fishing vessels from fishing within U.S. territorial waters.

But the protective strategy favoring U.S. fishermen did little to stem the swordfish onslaught. From 1987 to 1991, the fishery was hit with a double blow: total swordfish landings in the North Atlantic went from 20,000 metric tons to 15,000 metric tons and the average size plummeted from 165 pounds to 110. If the economic downturn wasn't enough of a problem for the fishery, it soon would have to deal with a major public relations issue: longline hooks indiscriminately caught a variety of sea life, including sharks, sea birds, and turtles, in addition to swordfish. Conservationists were up in arms that these organisms, many of them dead, were discarded, simply thrown back into the sea. A new word would find its way into the lexicon of fishermen and the general public alike—bycatch. And the bycatch was huge, estimated to be five to ten times greater than the total swordfish landings.

The few swordfish harpooners who plugged along during the period of rapid expansion of longlining have long argued that harpooning is both a sustainable and a selective way of catching swordfish. In particular, a hard-core group of Nova Scotia fishermen have attempted to create a niche market for harpooned swordfish, promoting that "harpoon-caught swordfish is the freshest you can catch." Their efforts appear to be paying off, with harpooned swordfish finding its way on the menu in many white-linen restaurants in Boston. "It's a superior product," says Roger Berkowitz, president and owner of Legal Seafoods.

While longline hooks snag juvenile, undersized swordfish as well as adults, the harpooner can and will target only fully grown swordfish. Maybe Zane Grey expressed it best in his writings about the burgeoning harpoon swordfishery in New England: "There is no evidence of any change in their abundance, either increase or decrease. Fishermen agree that they are as plentiful as ever, nor can any change be anticipated. The present mode does not destroy them in any considerable numbers, each individual fish being the object of special pursuit. The solitary habits of the species will always protect them from the wholesale capture, so destructive to schooling fish."

But the words of neither the harpooners nor Grey stopped the bleeding that was occurring in the longline swordfish fishery. But the

PHOTO 13. Longline swordfish. Courtesy of NOAA.

wound was now bigger than first thought when it came to light that swordfish represented a significant bycatch in the fisheries of Japan and Taiwan, which used longlines primarily to target bigeye and yellowfin tuna. According to data gathered by fishery managers, Japanese longliners, as far back as 1980, hooked over eight thousand swordfish, and five thousand to six thousand were already dead when returned to the water.

Bolder, more decisive action was required. Finally, in 1990 vested parties within the International Commission for the Conservation of Atlantic Tuna (ICCAT)—an intergovernmental organization charged with managing tuna and tunalike species in the Atlantic—proposed a total catch quota for North Atlantic swordfish. The following year, the National Marine Fisheries Service (NMFS), the branch of the federal government responsible for managing U.S. fish populations, set a swordfish quota of 6.9 million pounds for the American fleet, approximately two-thirds of the previous year's catch. Once the quota was met, the fishery was shut down until the next year. Fishermen would soon come to see an underlying truth to a quota: if I don't catch it, someone else will.

Risks are an integral part of commercial fishermen's lives; they readily acknowledge and accept them. But with the recently imposed limits on a fishery, some pushed the boundaries of safety in order to stock their hold with swordfish. Such was the case of Billy Tyne, captain of the swordfish boat *Andrea Gail*. As Sebastian Junger relates in his gripping nonfiction account *The Perfect Storm* (1997), Tyne was under pressure to turn around a heretofore unproductive season of fishing. When Tyne steered the *Andrea Gail* out of Gloucester, Massachusetts, on September 23, 1991, he would be laboring under a quota for the first time in his life. Tyne made, which would prove to be a major error in judgment, the decision to fish the remote Flemish Cap, the easternmost extension of the broad Grand Banks, with a monster storm bearing down on them. Pounded by freakishly high waves and hurricane-force winds, the *Andrea Gail*, hundreds of miles from land, never made it back to port, with all aboard lost.

The following six years saw a lot of posturing both within the national and international communities of resource managers, but with little

substantive gain—swordfish landings were estimated to still be above sustainable rates. For its part, the fishing industry remained in a state of denial, fighting any conservation measures every step of the way.

But a sea change was on the horizon, bringing the plight of the swordfish directly to the public. In 1998, the U.S. National Resource Defense Council and SeaWeb hired Fenton Communications to conduct an advertising campaign to promote the assertion that the swordfish was in danger due to its popularity. The "Give Swordfish a Break" promotion was widely successful, and chefs and restaurant owners refused to offer swordfish on the menu. Politicians scrambled to get in on the rising groundswell of public support for the swordfish. President Clinton called for a ban on the import and sale of all swordfish in U.S. markets.

In spite of bureaucratic wrangling, progress was being made to restore the swordfish population to a healthy level. By 2002, stock assessments determined that the North Atlantic swordfish biomass was at the 94 percent level needed for maximum sustainable yield. Two years later, the use of circle hooks in the longline fishery became mandatory, with the goal of reducing bycatch and facilitating the release of undersized swordfish.

In 2007, U.S. officials worked with foreign representatives from ICCAT to formulate an ocean-wide policy regarding swordfish catch. The result: in 2009, the North Atlantic swordfish was considered completely rebuilt—a major success story in the otherwise poorly regulated fishing industry. But constant vigilance is required to ensure that swordfish populations remain healthy. The NMFS assiduously tracks the status and health of the swordfish population under its jurisdiction. And in cooperation with its international partners, NMFS has been instrumental in balancing the needs of conservationists and traditional fishermen.

Lines In: Swordfishing

The swordfish stock rebound was a boon to the recreational fishery, particularly in southern Florida, where close access to the Gulf Stream affords an easy run to the fishing grounds. (Though swordfish have a wide distribution throughout the Atlantic, most other billfish

destinations, such as the Azores, have not developed an extensive recreational swordfish fishery, primarily due to competition from commercial longliners.) Today's swordfishing varies significantly from the time of Zane Grey, with swordfish now being targeted both day and night. But the strategies employed during the day versus the night are as different as, well, night versus day.

Daytime swordfishing is done at great depths, 1,500 to 2,000 feet, where the swordfish are feeding during the day. To reach these depths in a strong current requires weight—lots of it—in the fifteen- to twenty-pound range. Since the Gulf Stream flows faster off Miami and Fort Lauderdale than it does in the Florida Keys, another daytime swordfishing hot spot, anglers generally opt for the heavier weight when fishing these sites.

The bait, generally a whole squid or slabs of dolphin or bonito, is securely impaled on two hooks. The whole rig—sinker and bait—is carefully lowered through the water column to ensure the line is straight down to the target. This type of deep-dropping fishing necessitates the use of a heavy rod and reel combo. Because of the extreme depths, electric reels are the sensible choice. But even with an electrical reel, it will take over 10 minutes to retrieve 1,800 feet of line. While pressing a button may be a simple way to reel in a prize fish from the depths, be aware that the use of an electric reel may disqualify the angler from any subsequent fish records and is not standard gear in International Game Fish Association–sanctioned tournaments.

Once the rig reaches the bottom, the angler reels it up a bit to prevent the lead weight from snagging on bottom debris or structure. While the boat drifts along in the current, close attention is paid to the depth sounder, which yields a visual picture of the bottom contours. Irregular-shaped bottom features, such as seamounts, create eddies that trap bait and provide opportunities for swordfish to ambush this prey.

With the rod in one of the boat's rod holders, a constant vigil ensues—watching the rod's tip, hoping that it may yield visual clues about what might be happening to the bait far down below. A slight irregular bob of the tip could be nothing more than a small swordfish slashing at the bait with its bill. But assuming the swordfish swallows the bait, it will either make a determined run away—abruptly pulling the

tip down and line off the reel—or it might swim up, fighting the heavy sinker, which puts less pressure on the rod, resulting in the tip rising.

Once the fish is solidly hooked, the first stage in the fight is to retrieve the heavy sinker with the assistance of the electric reel, so that it can be removed. With the line unencumbered by this weight, the angler has the choice to keep using the electric reel to bring the swordfish to the surface or, if feeling particularly energetic, to switch over to manual cranking by disengaging the electric reel. While all this heavy tackle and deep-dropping can be cumbersome, the biggest draw to daytime swordfishing is the fish can be big, averaging over 150 pounds, with some topping out at over 400 pounds.

While the swordfish that are caught at night generally are smaller than their daytime counterparts, the action can be furious, with multiple hookups a common occurrence. Most anglers drift along in the Gulf Stream with four lines in the water. Baits are suspended at various depths, ranging from fifty to five hundred feet in order to cover the water column that nocturnal swordfish might be feeding in. Light sticks, which attract prey species, may also be attached to the lines.

With regard to light, some charter captains have steadfastly held to the opinion that certain lunar phases are more conducive to catching swordfish than others. The rationale being, in part, that the amount of moonlight entering the water controls the distribution of prey species that would attract swordfish. While I know of no systematic research that has demonstrated a specific relationship between catch and moon cycles in the recreational fishery, a study by Miguel dos Santos and Alexandra Garcia of the Portuguese longline fishery showed that the full moon corresponded to an increase in swordfish catch.

Anglers who consume their swordfish catch should be aware of the possible high-level concentrations of pollutants that may be found in the fish's tissues. Since the early 1970s, the Food and Drug Administration (FDA) has been monitoring the level of mercury in swordfish and other pelagic species. While mercury is a naturally occurring substance, found in air, water, and soil, anthropogenic activities have increased its concentration in the environment. Elsie Sunderland, a Harvard scientist, and her colleagues at the Unites States Geological Survey have shown that the total mercury levels in the North Pacific Ocean have increased

about 30 percent over the last twenty years. The researchers attribute the rise to an increase in atmospheric emission rates, particularly from industrial giants, like China. Carried by winds over the ocean, the mercury washes from the air to the ocean.

Scientists have known for some time that mercury that enters aquatic ecosystems can be transformed (methylated) into a highly toxic form of mercury called methylmercury, given the right conditions. Plants absorb the methylmercury from the water, and the amount rapidly accumulates up the food chain. The amount of methylmercury found in swordfish, an apex predator, may be thousands of times that found in microscopic phytoplankton, which occupy the base of the food chain. Age and size of the swordfish also comes into play—older and bigger fish have highest contaminant concentrations.

While swordfish sold on the commercial markets is closely monitored to make sure that methylmercury levels remain below the FDA-prescribed 1.0 ppm level, anglers should moderate their consumption of sport-caught swordfish. Err on the side of caution but still enjoy a swordfish steak or two. For as John Hersey said, in his book *Blues*, about eating a bluefish that had been caught by his fishing companion, "And all the more sweeter because you caught it."

7

Billfish Bantamweights

SPEARFISH, WHITE MARLIN, AND SAILFISH

For some adventurous souls, catching billfish from a traditional watercraft, like a boat, has lost its appeal, or at least diminished in intensity, and they have sought out other more exotic and, yes, dangerous methods. The use of kayaks has in recent years exploded onto the billfish scene. In addition to the adrenaline rush from seeing a hooked billfish streaking off into the distance, the draw for many anglers is the intimacy they experience with their surroundings. Sitting in a small plastic craft that is bobbing just above the water, the angler feels that he is part of the fish's environment. Doug Olander, editor of *Sport Fishing* magazine, writes that the kayak provides an "unimaginatively different perspective of the sea. The vastness of the ocean becomes at once overwhelming, just in case you happen to be jonesing for a reminder of your own insignificance." Even kayak billfish clubs have sprouted up, with membership contingent on the capture and release of a billfish.

So how does kayak fishing work? One scenario depends on a boat trolling for billfish in the traditional manner. Upon hookup, the kayak is launched from the boat, and the rod is passed to the angler who is now aboard the kayak. From his new setting, the angler is alone with his catch; no help is provided by the mother ship. In the second case, the boat is used only to take the angler out to the fishing grounds. In this do-it-all-yourself situation, the angler trolls bait directly from the kayak—the kayak's foot pedals provide the necessary propulsion—hooks, fights, catches, and releases the fish. In either case, the hooked billfish may drag the kayak a number of miles, the angler's version of a New England whaler's "Nantucket sleigh ride."

The fight's duration from a kayak can be much longer, even with a small billfish, than from the cockpit of a fifty-foot charter boat, which can maneuver to gain the upper hand in the battle. But the combined resistance from the reel's drag and from the towed kayak ultimately tires the fish. Though the fight may be going in the angler's favor, it is not quite the time for celebration because even an exhausted billfish may have a few jumps left in it. At this stage, the angler has two choices: cut the line to facilitate the release or attempt to remove the hook. With regard to the former, the angler has only to touch the leader for it to be recognized as an official catch before cutting the line. The latter is a bit more daring and dangerous, requiring that the bill of the fish be immobilized. The angler must securely grab the bill in one hand and then remove the hook with the other—a task not for first-timers.

Matt Watson, dubbed "New Zealand's Steve Irwin," has downsized the vessel to pursue billfish—using a surfboard. The board, with Matt sitting astride it, is towed behind a boat, which trolls a teaser to attract a billfish. Once the fish is in sight, Matt casts a bait to it and upon hookup releases the towing rope. He used this technique to catch a marlin, which, in the process of the ninety-minute fight, dragged him approximately five miles. I'm not sure if during this time Matt could relate to Hemingway's Santiago being towed in his tiny skiff by a deep-running marlin, but he did express concern as his billfish dragged him precariously close to an oncoming container ship. Luckily, he was able to release the billfish before any mishap.

Matt's most extreme, and very controversial, fishing outing was to dive from a hovering helicopter onto the back of a cruising marlin. An underwater camera caught him wrestling the giant fish to the surface before letting it go. In subsequent interviews, he refused to divulge the details of such a complex operation, calling into question by many whether his so-called "catch" was just another version of a well-worn fish tale.

Spearfish

Though the white marlin, sailfish, and spearfish are all members of the same family that includes the blue marlin, what really sets them apart from the blue marlin is their size. Rarely do these species top out over

100 pounds, while, in comparison, the blue marlin can grow to over 1,300 pounds.

Of these billfish, the longbill spearfish (*Tetrapturus pfluegeri*) and the roundscale spearfish (*Tetrapturus georgii*) are probably the most enigmatic—little is known about their biology, habits, and movements. What data have been accumulated about these species show they have a broad distribution throughout the Gulf of Mexico and the Atlantic Ocean but are not concentrated in any particular area. (A third spearfish, the Mediterranean spearfish [*Tetrapturus belone*] is found mainly in the Mediterranean Sea.) Pelagic in nature, they prefer deep, blue water. But tagging studies have shown that spearfish spend most of their time within seventy-five feet of the surface, rarely diving deep into the water column as do swordfish. While in the surface waters, spearfish consume mainly small and medium-sized squid and fish, including flying fish, dolphin, needlefish, and pilot fish. Spearfish reach sexual maturity after two years and rarely live to be more than four or five years old.

As with all members of the Istiophoridae family, the body of both spearfish is dark blue on the back, shading to brownish-white along the sides, and white on the belly. (Despite their names, the white and blue marlin have this same coloration.) While the longbill spearfish lack the prominent vertical stripes commonly found in marlin and sailfish, the roundscales have stripes that bifurcate halfway down the side, giving the appearance of a thicker stripe. Both species have a slender, lightweight (usually under fifty pounds) body that tapers to a lunate-shaped caudal fin. They are the smallest of all the billfish. In cross section, these fish are distinctively compressed from side to side, as opposed to the round or oval cross-sectional shape of a hefty blue marlin. Their long dorsal fin is highest toward the head (higher than in marlin, but lower than in the majestic sailfish). But the use of fins as an identifying marker to differentiate among different types of billfish can lead to confusion.

For years, some old salts would speak of catching a relatively uncommon billfish—the hatchet marlin. The fish looked like a white marlin, but its fins were different. In general, white marlin have rounded dorsal and anal fins, while the fins of the hatchet marlin gave the impression to anglers to have been cut straight across, like with a knife or hatchet. The skeptical billfish community dismissed the idea of a new Atlantic

billfish, taking the stance that the hatchet marlin was just a white marlin with a fin variant.

And that prevalent opinion held for a number of years until the genetic genie was released into the fray. As reported by John Graves in *Marlin* magazine, he and his colleagues Bruce Collete and Jan McDowell have routinely collected genetic samples from white marlin and hatchet marlin that were brought to the weigh station during the Mid-Atlantic $500,000 Tournament. After painstakingly analyzing the samples, they discovered that the majority of the hatchet marlin were indeed genetically different than the white marlin and more closely related to the spearfish.

But where exactly did their fish fit within the billfish family tree? While attending an international billfish symposium to present their findings, the three researchers were intrigued by the talk of Mahmood Shivji, who discussed the results of his own genetic analysis of billfish specimens obtained by fishery observers aboard longline vessels. As we have seen, he was able to confirm that the roundscale spearfish is a distinct species. Comparing results and samples, Graves's and Shivji's teams were able to confirm that they were looking at a single "new" species with two different common names. Since the species is genetically a spearfish, the roundscale spearfish is the common name now being used, and the roundscale is officially recognized as a member of the istiophorid genus *Tetrapturus*.

But we've come almost full circle with regard to differentiating billfish. Without a geneticist on hand, are there any visible traits that allow the average person to distinguish a white marlin from a roundscale spearfish? First piece of advice: avoid looking at the shape of the fins. Both whites and roundscales can have truncated dorsal and anal fins, although the cutoff shape is more common in the spearfish. Positive identification relies on three anatomical differences between the species.

The first difference is the distance between the fish's urogenital vent (located just in front of the anus) and the anal fin. The distance on the white is two inches, and on the roundscale between five and six inches. Of course, unless you're carrying around a tape measure and keen at lifting the fish out of the water to rigorously inspect its underside, this method may prove to be the most impractical.

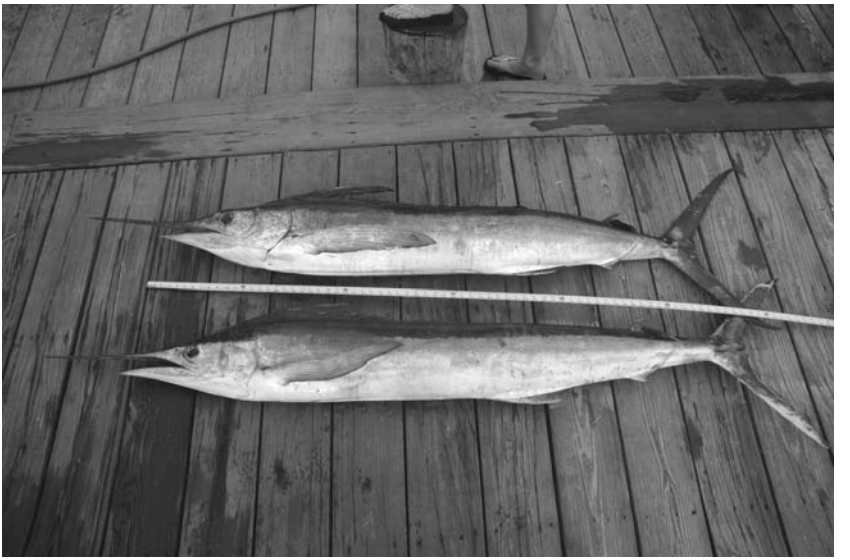


PHOTO 14. White marlin (top), roundscale spearfish (bottom). Courtesy of NOAA.

If the fish is up close to the boat, as it often is before its release, analysis of the appearance of its scales can be a helpful clue. The oval scales of the spearfish are quite distinct, giving it an almost polka-dot appearance in the water. In comparison, the flat, thin scales of the white marlin are not very noticeable, contributing to its overall smooth-looking exterior.

The last part of the identification trilogy is the branchiostegals—tiny bone extrusions located just below the gill cover. The relative length of these features varies between the two species, being longer on the white marlin. But unless both species are present for comparison, this may be a difficult call for the amateur.

While some anglers may go to the extra trouble to correctly identify their catch using the diagnostic characteristics above, billfish tournaments in the future may be required to make indisputable, positive identification. From the archived tissue samples collected over the years at the Mid-Atlantic $500,000, Graves determined that in 2003, 2005, and 2010, the majority of "white marlin" brought in to be weighed were

actually roundscale spearfish. The data for the entire sampling period (1992 to 2010) showed that of the 271 billfish initially viewed as white marlin, 57 were instead roundscale spearfish, almost 22 percent of the total landings.

The propensity of spearfish to be intermingled with white marlin, and not, say, blue marlin or sailfish, may, in part, be related to the temperature tolerance of these billfish. Both species can tolerate cooler water—white marlin (68°) and spearfish (70°)—than either the blue marlin (74°) or sailfish (72°). The limited data on spearfish movement appears to show that they arrive at most billfishing sites when the water temperatures are on the cool side.

Though the longbill and roundscale spearfish appear to frequent the better known billfishing grounds of the Atlantic, they are not caught in great numbers, possibly because most anglers simply do not target them due to their diminutive size compared to other billfish. Most spearfish catches are incidental.

The paucity of hookups may also be because of the use of big baits or lures in the blue marlin fishery. Due to their small mouths, spearfish cannot consume these larger offerings that are trolled offshore. Anglers intent on catching a spearfish should consider downsizing—reduce the size of the teasers, baits, leaders, and hooks—while employing the same tactics as for bigger billfish. With the appropriate light tackle, spearfish will put on an aerial display—jumping numerous times clear of the water—which is second to none among the other billfish.

In comparison to the blue marlin and white marlin fisheries, the number of sites to seek out spearfish is limited, due, in part, to the lack of a supporting infrastructure. But volcanic islands, with their combination of underwater structure, upwelling currents, and close proximity to blue water, seem to hold a special appeal to spearfish and should be first on an angler's list of places to target spearfish.

Spearfish Angling Destinations

AZORES, CANARIES, AND MADEIRA: The waters around these islands are home to big spearfish. The records of the International Game Fish Association show that the three biggest longbill spearfish ever caught on rod and reel came from these islands, with the all-tackle record of

127 pounds from the Canaries. But since most boats are after big blue marlin, trolling thirteen-inch lures—far too big for spearfish—chartering a boat specifically for spearfishing can be difficult.

ITALY: Despite being the home waters of the Mediterranean spearfish, Italy is definitely not a hotbed of recreational spearfishing. Most anglers here concentrate their efforts on the bluefin tuna. But local pockets of interest are sprouting up, such as Siracusa and Marina di Ragusa in Sicily, where anglers troll small feather jigs in the Strait of Messina.

MEXICO: While not having the concentration of spearfish that the eastern Atlantic archipelagos have, Cozumel, on the Atlantic side, has a fair share of spearfish action, albeit indirect, because local captains troll small baits and employ light tackle when angling for sailfish and white marlin.

White Marlin

As opposed to some spearfish, the white marlin is a better-known species, at least from a biological standpoint, having been studied for decades. The earliest descriptions of this species date back to the middle of the nineteenth century, when the taxonomist Felipe Poey called it *Tetrapturus albidus*, which loosely means a vigorous marine fish of whitish color. For years to come, the white marlin would be part of the genus *Tetrapturus*, which includes the aforementioned spearfish and the striped marlin of the Pacific Ocean—all, indeed, exhibiting a high degree of physical energy. But by the 1960s, some skeptics expressed doubt about the validity of the long-standing relationships within the istiophorid genera. Who fit where, and who was related to whom?

The composition of the billfish family tree was viewed to be in a state of flux. By the end of the twentieth century, classical taxonomy, based primarily on morphological analysis of an organism, would come up against the genetic analysis of a species. The result? Modern assessment techniques would have the upper hand, and the white marlin would occupy a new branch of the billfish tree—*Kajikia albidus*.

As we have seen, the overall appearance of the white marlin is very similar to that of the spearfish. The differences that exist between the

PHOTO 15. White marlin on the hunt for prey. Courtesy of Tom McMurray.

two species are subtle: the white has faint vertical bars on its body, and its first dorsal fin has many small black dots. Neither of these characteristics can result in a clear-cut distinction between these fish.

The white marlin is widely distributed throughout the Atlantic Ocean, ranging between 45° north latitude and 45° south latitude. Over this great expanse of ocean, it roams the waters above the thermocline, often frequenting regions with distinctive bottom features, such as drop-offs, canyons, and shoals. When near the surface, the white marlin often swims with the upper lobe of its caudal fin sticking out of the water, an activity called "tailing."

As with blue marlin, white marlin rely on their keen sight to detect and catch prey, which includes squid and bony fish, especially flying fish, mackerel, and small dolphin. However, lacking teeth, a common trait of all billfish, white marlin are limited to animals that can be swallowed whole. While white marlin may use their bills in capturing food, the fish in their stomachs rarely have the slash marks common to the feeding habits of some other billfish. To say that the white marlin and other billfish suffer from indigestion, as do humans, may be a bit of a

stretch; they appear to rid themselves of indigestible items, like squid beaks, that may lodge in the stomach wall by routinely everting their stomach and then swallowing it. Anglers have also noted billfish with their stomachs protruding from their mouths, probably a reflex action on the part of these fish when under stressful conditions, like being hooked and fought. Stomach eversion seems to have no negative effect on the health and survivability of a billfish that has been caught and then released.

During their migrations from and to their subtropical spawning sites, white marlin generally travel alone or in pairs but sometimes form small groups to take advantage of feeding opportunities. There is only one spawning event per year, which occurs in deep, blue oceanic water. Little is known about the biology of the eggs and larvae, as they are difficult to identify. But like some other billfish larvae, the white marlin juveniles lack a bill, and predation by other species is very high.

Relatively recent population assessments have determined that the white marlin is among the most overexploited pelagic fish in the Atlantic. Its biomass has declined to about 12 percent below the level necessary to maintain a sustainable population. The decrease in numbers is attributed to those marlin taken as bycatch on longline fishing gear targeting tuna and swordfish and those caught on rod and reel in the multimillion-dollar recreational fishing sector. So great is the concern about the declining populations, petitions to list the species under the Endangered Species Act were seriously debated in 2002 and again in 2007. Listing the fish would have had a marked economic impact, particularly in some white marlin tournaments that generate and infuse considerable sums of money throughout the recreational fishing industry and the local economy.

But a 2009 study published in the journal *Endangered Species Research* paints a potentially even bleaker picture for the white marlin, casting into doubt previous population assessments. A team of researchers, led by Lawrence Beerkircher of the Southeast Fisheries Science Center in Miami, Florida, has found that of 1,433 fish samples collected between 1993 and 2008 that were presumed to be white marlin only 1,047 were marlin. The remaining 396 were roundscale spearfish, a finding that was consistent with the aforementioned analysis by Graves and his colleagues.

The fact that 27 percent of the catch was initially misidentified raised a red flag to the researchers about the robustness of the white marlin population. Is the actual number of Atlantic white marlin smaller than first thought? And if so, what are the implications for any future attempt to list the marlin as endangered? With regard to the first question, Beerkircher and his colleagues would show through computer simulations that variations in the ratio of white marlin to roundscale spearfish could, indeed, alter projections of white marlin numbers, emphasizing the influence that species misidentification could have on the accuracy of past assessment. For example, if the ratio has been stable, the current assessment results are correct, and both species have declined in a similar manner. But if the relative number of roundscales increased over time, causing the ratio to decrease, then the white marlin population size is worse off than originally thought.

An actual population assessment of white marlin conducted in 2006 indicated a slight increase in its numbers, which was one of the reasons for its removal from the NOAA's Species of Concerns List. Whether this was the right call or not is debatable based on the above findings that show that a simple case of mistaken identification can throw into question all that we thought we knew and understood about a particular species. In order to unearth the true status of the white marlin population, Beerkircher argues that it "will require conducting population assessments with updated roundscale spearfish proportions." In addition, he states, "new species-specific monitoring measures will be essential for achieving this goal and aiding rebuilding of white marlin populations." Genetic research has not only paved the way to better decipher the phylogeny of billfish but also has led billfish experts to significantly reevaluate long-held beliefs and develop new paradigms in billfish science.

While the biology and fate of the white marlin has attracted increased attention within the scientific community, its popularity as a premier game fish species also continues to rise among anglers, as evidenced by the growth of tournaments specifically targeting this species. As with spearfish, light trolling tackle is de rigueur for bringing out the best of these acrobatic fish. Ballyhoo, fished either naked or rigged with a small plastic covering, is the bait of choice. Many anglers prefer

PHOTO 16. White marlin jumping. Courtesy of Tom McMurray.

unadorned ballyhoo because it is easier for the fish to eat; the marlin positions the bait headfirst in its mouth before swallowing it. Since small ballyhoo are being pulled, small leaders are also in order to allow the baits to move naturally through the water. A fast troll, seven to eight knots, "skips" the bait across the sea surface, replicating a fleeing prey and drawing the interest of an excited marlin intent on chasing down the prey.

The baits are trolled from outriggers and flat lines. To increase billfish hookups on the latter, the line is twisted eight or ten times before inserting it into a flat-line clip. The twisted line creates friction, allowing the reel to be put into free spool. When the fish strikes the bait, the clip will release, and the fish feels very little or no pressure, allowing it to eat the bait.

To draw a white marlin into the trolling spread, many savvy anglers pull a hookless teaser close to the boat. A proven white marlin teaser is a squid daisy chain. When the fish comes up to the teaser, the mate

quickly pulls the teaser from the fish, and the angler is ready to "feed" the marlin, also known as "drop back." Dropping back is a technique all serious white marlin anglers have mastered and, in principle, involves letting an extra bait fall back behind the boat as naturally as possible. With the reel out of gear, clicker off, and thumb off the spool, the angler lets the line fall from the rod tip into the water for about five seconds. If the movement is performed smoothly, the marlin, feeling little resistance, will eat the bait, most likely leading to a solid hookup. If the hookup is missed, but the ballyhoo is still intact, the angler cranks the bait back to the surface, holds it there, and is ready to drop back again. A marlin often stuns the bait with its bill; so if it strikes with its bill, a dropped-back bait will simulate the stunned prey.

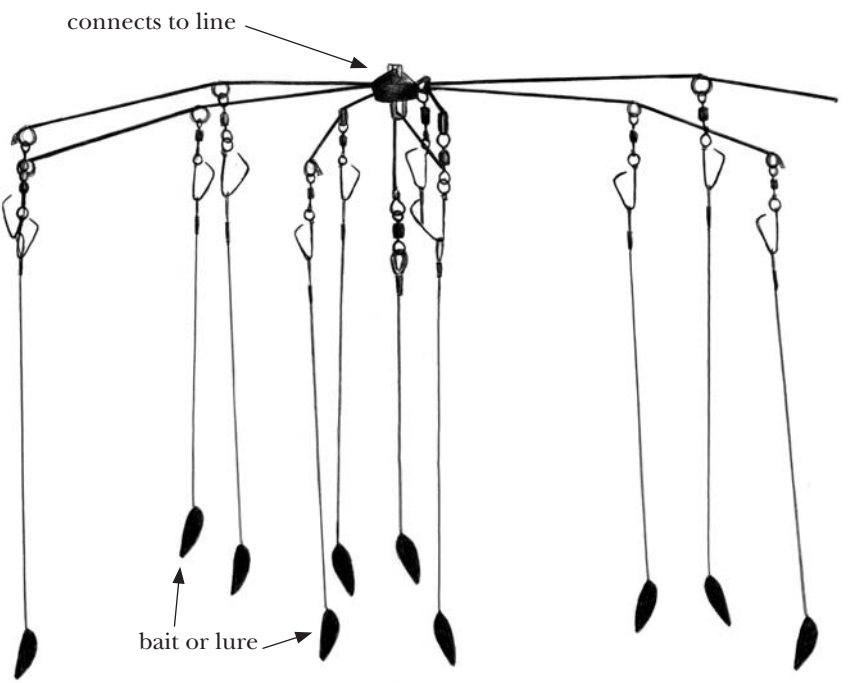


FIG. 9. Dredge. Courtesy of Rebecca Bunker.

PHOTO 17. "Lit up" white marlin with bright stripes. Courtesy of Tom McMurray.

Ken Neill, a practicing dentist in Virginia and an ardent white marlin angler, argues that any angler can increase his chances of a successful white marlin outing by using another type of teaser—the dredge. At its core, the dredge mimics a bait ball and, as opposed to surface teasers, is designed to be trolled slowly below the surface, out of the boat's turbulent wake. Artificial dredges are either holographic fish strips or rubber fish, while natural dredges use ballyhoo or mullet. Whether it's an artificial or natural dredge, Neill is convinced that they both work and should be in the tackle arsenal of any serious white marlin angler.

While Hemingway may have been content to sit in the fighting chair aboard the *Pilar*, all the while absentmindedly staring into the deep, blue Gulf Stream, white marlin fishing requires attention, watching the baits and teasers. A white marlin may appear in the trolling spread before anyone sees it, and that can spell disaster. With the rod in hand before the fish eats the bait, the angler is in control of the situation—able to interpret the fish's actions and react accordingly—and the odds increase markedly for a solid hookup. If the fish beats the angler to the rod, the advantage goes to the fish.

Speaking of that fighting chair, there's no need to use it when hooked up with a white marlin. And there's no gritting of the teeth and no muttering the motto spoken by Hemingway: "*Il faut (d'abord) durer*"—first one must endure. This is stand-up fishing at its best, with the light tackle not only easy on the angler but also allowing the fish to perform to its maximum capability. An upright angler has the flexibility to maneuver to either the port or starboard side of the boat, depending on whichever side the fish is hooked. But while the fight is on, others aboard should keep a watchful eye for the possibility of another marlin's sword piercing the water and be ready to get that extra bait out to the fish. White marlin fishing stands out as a hands-on, attention-to-detail angling experience, most definitely not a laid-back undertaking for the casual angler.

Many of the same blue marlin haunts are also home to excellent white marlin fishing. The exception being the eastern Atlantic, where there is only a limited white marlin rod-and-reel fishery.

White Marlin Angling Destinations

BRAZIL: Most of the largest white marlin in the record books, including the all-tackle record of over 181 pounds, come from the warm waters that bathe the Brazilian coast. In particular, the aforementioned fertile Royal Charlotte Bank experiences a large number of white marlin from October to March. Compared to the billfishing grounds in the United States, these waters receive relatively little fishing pressure.

DELAWARE, MARYLAND, AND VIRGINIA: In these mid-Atlantic offshore waters, white marlin are available from May through October, with August and September prime months. During this period, the majority of marlin will be found in deeper water, 3,000 to 6,000 fathoms, particularly over submarine canyons that cut deeply into the continental shelf and slope. Before the present-day heavy fishing pressure, the Jack Spot, a planktonic-rich bottom structure located only twenty-two miles south of Ocean City, Maryland, was for many years the most productive and famed white marlin site in the United States. Named after Captain Jack Townsend, one of the pioneers in white marlin fishing during the 1930s, Jack Spot yielded 171 whites in a single day, July 29, 1939. Even decades later exceptional white marlin fishing

continued, with over 2,000 fish caught or released per year between 1969 and 1971. Though the Jack Spot still yields white marlin, most anglers opt for the longer offshore run to avoid the overcrowding that can occur on this site.

NORTH CAROLINA: Due to its close proximity to the Gulf Stream, sites including Cape Hatteras, Oregon Inlet, and Ocracoke Inlet are jumping-off points for first-class white marlin fishing, with August and September prime months. Trolling ballyhoo on light tackle is the preferred method when targeting these fish.

VENEZUELA: The prime billfishing ground is the aforementioned La Guaira Bank, which hosts great concentrations of white marlin in season. Generally, the whites will patrol the edges of this underwater structure, preferring the deeper, blue water. While white marlin can make an appearance at almost any time, autumn is considered the best time to target them.

Sailfish

The Atlantic sailfish was first described by George Shaw and Frederick Nodder in 1792, when they assigned it the name *Xiphias platypterus*, essentially placing it incorrectly in the same family as the swordfish. Over time, taxonomists would recognize the mistake and the sailfish (*Istiophorus platypterus*) would take its proper place in the family of spearfish, white marlin, and blue marlin.

While the white marlin and roundscale spearfish are morphologically very similar, there is no mistaking the sailfish, with its huge, black-spotted, blue dorsal fin, which runs most of the length of the body. In addition, vertical bars of pale blue spots are found along both sides of the body. When the sailfish is excited or stressed, the bars flash iridescently. Normally, the darkly pigmented cells, melanophores, of the bars do not lend any color to the fish. But during periods of stimulation, the cells contract their pigment to expose vibrant metallic colors in the skin below. As told to Jennifer Holland, on the staff of *National Geographic*, Australian neurobiologist Kerstin Fritsches likens the cells' responses to "venetian blinds"—opening and closing to change the nature of skin coloration.

The sailfish's bill is longer than that of the spearfish, usually twice the length of the lower jaw. The fish's moderately fusiform body, powerful lunate caudal fin, and highly efficient musculature make it one of the fastest fish in the ocean, with speed bursts approaching seventy miles per hour.

Like other billfish, sailfish have a wide distribution throughout the tropical and temperate waters of the Atlantic. Though pelagic in nature, they are not averse to migrating to warm, nearshore areas in search of prey. (North Carolina anglers have on occasion observed sailfish swimming a short cast from the end of a pier.)

The sailfish's diet is marked by variety: squid and octopus make up approximately 20 percent of its diet, with the rest being bony fish. While mackerel and tuna are the most common fish consumed, also eaten are jacks, ballyhoo, needlefish, and herring. Surprisingly, while flying fish were found in the stomachs of sailfish, they were only a minor component of their overall diet. These prey items indicate that feeding occurs both near the surface and at mid-depths along the edges of currents and reefs.

To attract a potential mate, the female sailfish slowly cruises the surface waters, with her prominent dorsal fin extending above the water surface—a sign that she is ready to spawn. One or more males will accompany her to fertilize her eggs as she releases them. A large female may release 4 to 5 million eggs, and those eggs that survive the rigors of the pelagic environment yield tiny sailfish larvae that, like other billfish larvae, lack the jaw characteristics of the adults. The larvae grow rapidly, reportedly reaching a length of four to five feet and a weight of twenty pounds in one year. The growth then slows down, and adults attain an average weight of fifty pounds.

While the techniques employed for targeting white marlin—trolling, use of teasers and dredges, and drop backs—also work well for sailfish, some enterprising anglers have over time led the way in changing how the angling community at large views billfishing. New methodology and gear found their way into the world of billfish anglers, expanding their horizons.

The sport of fly-fishing is an old one, dating back centuries. Historically, it is often associated with the landed gentry of Britain who reveled in the joy of enticing a trout to rise from a bubbling limestone

PHOTO 18. Gulf Stream sailfish. Author's photo.

stream and to strike an exquisitely hand-crafted fly. One of the earliest writers extolling the virtues of fly-fishing was William Trotter Porter, an American journalist and newspaper editor. As noted by Francis Brinley in his biography, Porter wrote in the *Turf Register* in the 1830s that "Fly fishing has been designated the royal and aristocratic branch of the angler's art . . . the most difficult, the most elegant, and to men of taste, by myriad of degrees, the most exciting and most pleasing mode of angling." But Porter and the legions of fly-fishing aficionados to follow would vehemently argue that at its core, fly-fishing is intrinsically tied to the art of fly casting, delicately presenting a fly to a predetermined spot on the water.

Before the 1960s, the occasional sailfish would be caught by anglers trolling with fly tackle. But the trout and salmon devotees, while coming around to recognizing that other species could be caught on fly

gear, were adamant that the phrases "catching with a fly rod" and "casting and catching with a fly rod" were, indeed, quite different.

Taking up the banner of saltwater fly-fishing was Webster Robinson. After years of experimentation, "Doc" Robinson in 1962 succeeded in landing a Pacific sailfish on a fly, and the catch was officially recognized as the first billfish to be caught by fly casting. Two years later, the first Atlantic sailfish fell to a properly presented fly. From that date onward, fly-fishing would become a widely accepted method, even among the naysayers, of catching billfish, attracting a legion of hard-core devotees.

The system that Robinson worked on and perfected is dependent on teamwork between the angler and a companion in charge of a hookless teaser. The teaser is trolled behind the boat until a sailfish rises to inspect the offering. The person handling the teaser must then retrieve it back to the boat, all the while playing cat-and-mouse with an increasingly agitated and lit up sailfish and drawing the fish closer to the boat's transom. A moment of truth comes to the handler—when to pull the teaser from the billfish. Too soon and the billfish may lose interest; too late and the fish may be spooked by the boat. It's a critical time because the angler has stripped line from the reel, preparing to make that all-important first cast. With the decision made to remove the teaser, the call for "out of gear" goes out to the captain; so he can slip the boat into neutral. The rules stipulate that by the time the cast is made, the boat must be still in the water, so as not to impart any unnecessary motion or action to the fly.

It's now up to the angler to make the cast. But how? (Trout anglers commonly employ a quartering upstream cast to allow the fly to drift down to the fish.) Robinson would demonstrate through his early failures that oddly enough a straight-on cast, ahead of the fish, rarely resulted in a solid hookup. By far the best way for the point of the hook to obtain purchase in the fish's jaw is for the fish to take the fly as it swims away from the caster. To achieve this end, Robinson would cast his fly slightly behind and to the side of the fish, all the while imparting a noisy gurgling sound to the fly. (Robinson used a home-made Styrofoam popper.) Attracted by the commotion, the excited billfish, as Robinson rationalized and soon found out to his delight, would wheel around, smashing the fly at an angle. Invariably, the hook would find its mark. The saltwater tactic of using a hookless teaser to attract a fish

and then quickly replacing it with a baited hook or fly would soon be known as bait-and-switch.

Over the years, Robinson had continued success with this tactic, and early followers, such as Stu Apte, Lee Wulff, and Mark Sosin, religiously adhered to Robinson's method, setting numerous world records in the process. Apte, in particular, caught a still-standing record 136-pound Pacific sailfish in 1965. But while bait-and-switch would prove widely successful, anglers would also go through a learning curve in playing and fighting a fly-hooked fish. The first run of a hooked billfish can be a blistering one, where the fish literally strips hundreds of yards of line from the reel. At this stage, there is not much the angler can do but wait for the fish to tire. Often an exhausted fish will dive deep, hunkering down in an attempt to revive itself. At this stage, the primary objective of the angler is fairly simple: overcome the fish's resistance, lift, and gain some line.

Letting the rod do the work is a phrase that has found its way into angling lexicon. But what exactly does it mean? The weight of the sailfish will cause the rod to bend or bow. The ideal bend appears to be a parabolic one—the rod flexes relatively uniformly along its entire length. The stresses induced by the weight of the fish are distributed over the length of the rod rather than being concentrated at a point, like the rod tip, which could lead to rod failure. (The fly rods of Robinson's era were subject to breaking under heavy stress, but the use of new materials and improved manufacturing processes has made today's stronger but also lighter.) With a pronounced bend in the rod, mitigating the stresses, the fish's resistance weakens. The angler is able to exert sufficient pressure on the fish.

A fly rod, or for that matter any fishing rod, reduced to its essential elements is basically a lever, which like any tool should provide some advantage to its user. In playing a fish, the advantage achieved is that the rod tip moves a greater distance than the rod's butt, where the angler is applying the requisite force. In other words, more line is retrieved at the rod tip for limited movement of the hands positioned near the rod butt, and getting more line back on the reel means getting the fish closer to the boat.

We're now back to the concept of work but viewed from a physics perspective. The amount of work done in moving an object is equal to

the magnitude of the force applied by the distance through which the force is exerted. If we don't move the object (fish), then the work done is zero, regardless of the effort exerted and how much we grunt and sweat. The amount of work expended by an angler in lifting a ninety-pound billfish from a depth of fifteen feet to the surface would be five times greater than carrying a sixteen-pound bowling ball up a flight of stairs. Fighting a big fish is hard work. If the angler is pulling at an angle to the fish, let's say forty-five degrees, then the work increases by 42 percent.

A skillful captain can aid the angler by "backing down the boat"—that is, repositioning it so that the angler is not pulling at a severe angle to the fish.

Robinson and others would go on to catch more and different billfish species, all the while learning when to apply pressure on the fish, when to reposition the grip on the rod to maximize pulling power, and, yes, when to let the fish have its way.

The very nature of fly tackle—a relatively willow rod, light leaders, and limited reel capacity—restricts anglers with regard to the size of the fish they can target. While sailfish, white marlin, and spearfish are all excellent candidates for a fly-fishing outing, large blue marlin are generally out of a fly angler's league. To date, the largest billfish caught on a fly is a 260-pound Pacific blue marlin, while the largest caught with conventional tackle easily tops the 1,000-pound mark.

Though the use of fly rods dates back hundreds of years, one of the oldest fishing devices is the simple kite. First used by the Chinese, then the Polynesians, the kite found its way into the offshore angling community, where pioneering anglers George Farnsworth and Tommy Gifford extolled its versatility in catching fish. Gifford was so persistent in publicizing his angling exploits that he is often given credit, although erroneously, for introducing the kite into Atlantic waters. By the late 1950s, Captain Bob Lewis, a protégé of Gifford's, would carve out his own niche in kite fishing by introducing kites into the sailfish-rich waters off southern Florida. In principle, the technique was simple: suspend a frisky live bait over the water with the use of a kite. Lewis rationalized that the kite would keep the frantic bait swimming in tight circles very close to the surface and within easy reach of a sailfish that would be

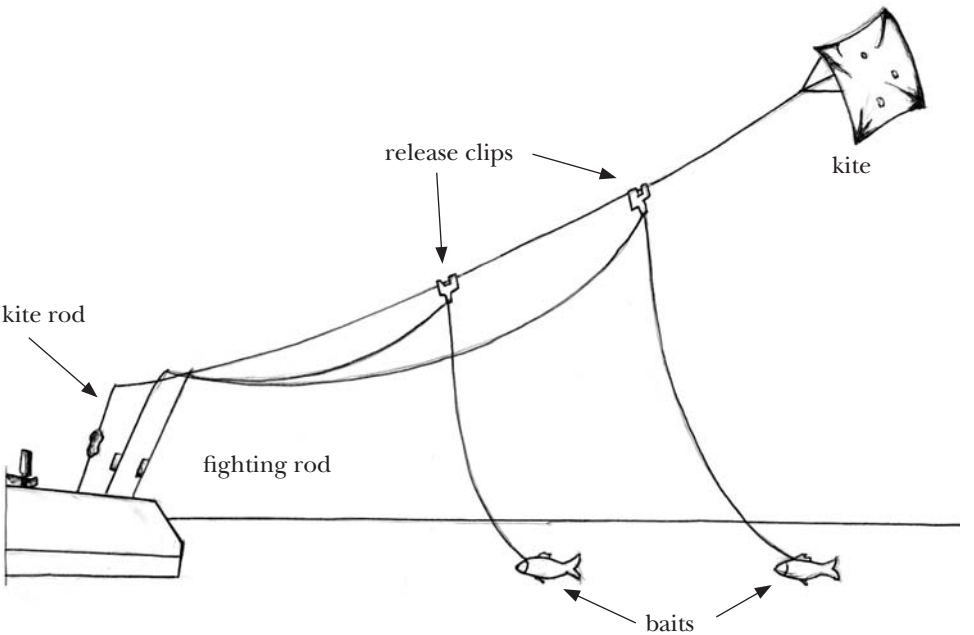


FIG. 10. Kite fishing. Courtesy of Rebecca Bunker.

attracted to the distress signals emanating from the bait. When the fish strikes, the bait separates from the kite line by means of a release clip, allowing the angler to fight the fish on a separate rod. In addition, the heavy leader material is suspended vertically above the bait and out of the water, leaving less line to spook a sharp-eyed fish. While Lewis may have at times been frustrated with a kite's tendency to dodge and dip wildly in unsteady wind conditions, he was consistently outfishing many of his contemporaries, many of whom would soon acknowledge the benefits of a bait splashing attractively under a fishing kite. One person who needed no convincing was John Dudas, a transplant from New Jersey, who was intent on finding a way of fishing not just one bait from a kite, as was the norm at that time, but instead multiple baits, which would cover a much larger swath of the ocean surface. A tinker at heart,

Dudas replaced the large wooden kite reel, which was always breaking down, with an electric reel of his own design. Matched with a short, fiberglass rod, which was outfitted with a tip that would swivel and pivot in changing wind conditions, the reel made it easier to launch and retrieve the kite. It wasn't long before Dudas was flying two kites from the boat's stern, with three baits suspended from each kite, and catching twice as many sailfish as his fellow anglers.

Once Dudas mastered the mechanics of flying the kites, he soon realized that his success would still depend on one basic fact: the quality of the bait. Live, spirited bait was needed in good supply, and in the 1970s in Miami, live bait meant pin fish, tinker mackerel, blue runners, and whatever else could be netted or caught. But bigeye scad, commonly known as goggle-eyes to the south Florida angling community, would prove to be the most effective bait for sailfish, as Dudas would learn. These indefatigable swimmers are hardy, able to survive hours on end while dangling from a kite.

While Dudas and, particularly, his sons learned to catch the elusive, nocturnal goggle-eye, most anglers today forego the effort and resort to buying them. But the price can be steep, particularly at tournament time, where one goggle-eye may fetch the seller ten dollars, and at least two dozen, at the minimum, may be needed for a day of fishing. With such an expensive commodity, most anglers do not impale the bait directly with the hook but attach the hook to the back of the fish by means of a bridle made from rigging floss, plastic ties, or tiny rigging bands. With this method, the goggle-eye will remain friskier for a longer period of time and avoid any injury from being impaled.

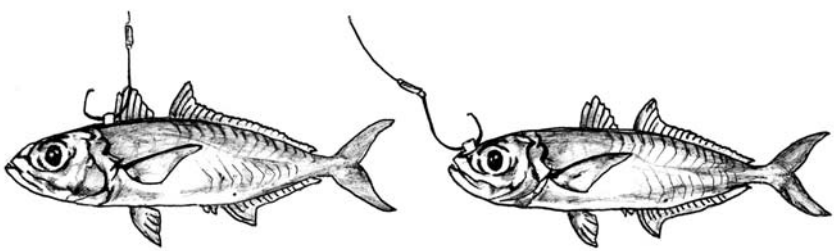


FIG. 11. Bridling goggle-eyes. Courtesy of Rebecca Bunker.

Whether trolling, fly-fishing, or kite fishing, sailfishing action can be outstanding wherever there is a concentration of these predators. For example, in the 2005 Sailfish Kickoff Tournament in southern Florida, four hundred fish were caught and released in one day, one every minute and ten seconds.

Sailfish Angling Destinations

ISLA MUJERES, MEXICO: This small island off the Yucatan peninsula translates to "island of women." Though there are a couple of tales as to how the island was so named, one goes something like this: the early Spanish explorers who landed on the island found only women; all the men were out fishing. And the main angling opportunity, as it is today, may have been for sailfish. From midwinter to early spring, sailfish and sardines migrate to the waters off the island. The draw is the shallow continental shelf that stretches eastward off the island. These plankton-rich waters, nourished by the Caribbean Current, which surges through the narrow Yucatan Channel, and by river discharge from the mainland, offer an abundance of food. The meeting of *Istiophorus platypterus* and *Sardinella aurita* is a primal act of the hunted and hunter, played out in the clear blue water of the Gulf of Mexico. Sardines that have formed a tightly wound bait ball fall prey to a school of sailfish that appear to have choreographed their every movement as they make repeated forays into the ball.

Angling for sailfish in Isla Mujeres is essentially old school—trolling dead ballyhoo on conventional tackle. No casting, no dropping baits—rules that are strictly enforced. John Dudas found this out; his one very successful sailfish outing here led to a ban on kite fishing in these waters.

SEBASTIAN INLET, FLORIDA, TO FORIDA KEYS: Zane Grey had it right. The waters off southern Florida support an abundance of sailfish. From Palm Beach in the south to Sebastian Inlet in the north is an eighty-mile stretch of offshore water known as "sailfish alley." Sailfishing here is mainly a winter-time activity, when bait migrates into this expanse of ocean. Plankton blooms attract a cornucopia of food items, including

herrings, sardines, pilchards, and anchovies, which fall prey to hungry sailfish.

The Gulf Stream races past the coast at a speed of five knots, the highest it will attain on its long journey northward. Distinct thermal and color edges develop on either side of the Gulf Stream, congregating both prey and predator alike, particularly if these edges coincide with bottom structure, such as reefs and rock outcrops. As opposed to the Fort Lauderdale–Miami area, where kite fishing is the main method for targeting sailfish, in sailfish alley anglers troll a variety of dead baits, including ballyhoo, goggle-eyes, and pinfish. The proximity of the Gulf Stream to the coast and the relatively narrow continental shelf means sailfish can be caught within sight of the urban skyline. Catch a sailfish in the morning and be back by early afternoon to partake in the South Beach scene.

SENEGAL AND GABON, AFRICA: Senegal is located between the Equator and the Tropic of Cancer on the western coast of Africa. Beginning in the 1960s, the country became recognized as a top light-tackle sailfish destination, with a number of world records set over the years. Large schools of sailfish congregate anywhere between five and twenty-five miles from the coast during May until the end of October, peaking in midsummer. The northeast trade winds, which blow strongest during the summer months, cause coastal upwelling of nutrients that are used by phytoplankton to initiate an oceanic food chain. The average sailfish weighs about sixty-five pounds, with the biggest, ninety pounds and more, showing up in August.

Straddling the Equator, Gabon supports a robust sailfish fishery, where anglers can troll productive waters within fifty minutes of leaving the dock. The fertility of the water results from the convergence of the cool Canary Current with the warm Guinea Current. Along this frontal zone, sailfish and other billfish congregate in fairly large numbers. On the average, anglers will have upward of a dozen chances at sailfish, which average about seventy pounds.

8

The Fate of Billfish

Conservation or exploitation—which way will the scale tip with regard to the billfish? Is there a common ground to be achieved among the vested interests? The search for answers may start with a glance back through history, when our relationship with nature was much simpler than it is today.

Hemingway is widely recognized as an accomplished and innovative angler, catching and keeping numerous fish. The essayist Paul Greenberg undertook the daunting task of estimating the number of marlin and tuna that Hemingway killed over his lifetime by poring over every photograph in the archives of the John F. Kennedy Library in Boston of Hemingway posing with these apex predators. From the visual evidence and with some realistic assumptions about how many caught fish were actually photographed, Greenberg determined that 530 marlin never made it back to the water. How do we interpret this number? Can Hemingway be viewed as an uncontrolled exploiter of this resource? It might be easy, and some may argue, such as People for the Ethical Treatment of Animals (PETA), necessary, to cast Hemingway as a plunderer of the seas—based on the kill number. But according to Hemingway's many biographers, he was an enigma, a man of contradictions. While, on one hand, he relished the thrill of doing battle with a worthy adversary, Hemingway was also keenly aware and appreciative of his watery surroundings, developing not only a bond with nature but with the fish he pursued. His writing often reflects this side of the man. Santiago, in *The Old Man and the Sea*, survives for three days and nights on an endless, dark sea that offers little solace, a lonely world bounded

by the gunwales of his tiny skiff, and his only connection to life, a tenuous one at that, is to the great and unseen fish far below. Both as a writer and angler, Hemingway may have embraced the old phrase "*piscator non solum piscatur*" (there is more to fishing than catching fish).

But Greenberg poses an interesting question: can Hemingway still be held accountable, to some degree, for the loss of marine life that has occurred after his death and is still occurring today? In the years to follow after Hemingway's big-game fishing exploits, magazines, books, and promotions ran numerous pictures of marlin, sailfish, spearfish, and swordfish, all hanging lifelessly back at the dock. (From one book, published in 1976, I counted 147 photos of this genre.) Greenberg is reluctant to skewer Hemingway, arguing instead that the author "did the service of fixing the big fish in time." Hemingway brought to our attention that it was normal to routinely catch big fish in sight of land, and as Greenberg summarizes, "If he had never given us a glimpse of that seemingly endless ocean, we might never have realized how much we have lost."

Keeping Tabs on Pelagic Wanderers

Population structure and change can be assessed only by first understanding the habits and nature of the individual species that make up the group. In particular, the need to unlock the secrets of billfish migration has been at the forefront for scientists, who, for years, had many unanswered questions about open-ocean movements, habitat use, and spawning and feeding sites. A migratory species also poses problems for resource managers, wrangling with national and international parties to set catch quotas, implement time and area closures, and limit unsustainable fishing practices.

The mid-twentieth century marked the first systematic attempts by fishery scientists to track these animals. Leading the way was Frank Mather, whose passion for fish led him into fisheries research. In 1952, Mather in collaboration with Howard Schuck attached the first "tag" to a bluefin tuna. The tag consisted of a slender, stainless-steel hook/anchor coupled with vinyl tubing that carried contact information on where to return the tag. This prototype tag was used extensively

for years until 1981, when a nylon barbed dart replaced it. By 1954, Mather began the Cooperative Game Fishing Tagging Program at Woods Hole Oceanographic Institute in Massachusetts, which continues today as the Cooperative Tagging Center (CTC), based in Miami. Over the years, Mather expanded his tagging efforts to include blue and white marlin, swordfish, and sailfish.

While the tags may have changed over time (the current tag is a medical-grade nylon double-barbed dart with a nylon or monofilament trace that displays the contact information of the tag agency), the procedure for tagging and the recovery of data has not changed significantly. Using a four-foot-long tagging stick, a crew member thrusts, with one swift motion, the metal end of the stick, which holds the tag, into the billfish's flesh. But tag placement is critical to the survival of the fish. The tag should be embedded in the muscle above the fish's lateral line as close to the dorsal spines as possible, avoiding the head, eyes, and gills. The resultant small wound will heal quickly and minimize any chance of infection. After the fish is tagged and released, the participant fills in the appropriate information—species, date, location, size in length, and gear type—on the reporting tag and mails it back to the CTC. When the fish is recaptured, the angler can call a toll-free number or mail the specifics of the recapture back to the CTC.

The major downside of this type of tag is that the only way researchers can learn anything about the movement and growth of the fish is that it must be recaptured in order to remove the tag. Unfortunately, the odds of recapture are not in the researchers' favor. In a historical review of release-recapture data collected by the CTC over a forty-year period, Christopher Jones and Eric Prince showed that of the 110,749 released billfish (blue marlin, white marlin, and sailfish), only 1,706 were recaptured—a paltry 1.5 percent overall, with blue marlin holding the bottom at 0.7 percent.

The reasons for the low return rate are complex, often centering on the unfounded fear of reprisals or sanctions. Longlining operations account for the majority of recaptured tagged billfish, but captains are reluctant to return the tags, opining that any caught billfish sheds a negative light on an already besieged industry. Foreign boats also recover a good number of tags, but language barriers and lack

of communication channels often prevent the vital information from reaching researchers in the United States.

Because of the low return rate, some anglers, both recreational and commercial, who are, and have been, indispensable to the success of the tagging program, have harbored the misconception that tagging yields little information of value. Their feelings have translated into action, and many have reduced activity in the program. Along with the CTC, the Billfish Foundation, a conservation organization that began tagging billfish in the 1990s and is now the largest tagging entity, is actively attempting to re-engage anglers into the tagging program and is at the forefront of highlighting that tagging is the most cost-efficient method to study migrating fish.

But all the publicity doesn't alleviate the main problem that migratory billfish swim in very big oceans, and the tags can provide only limited spatial information. Even in the 1950s, Mather was resigned to the fact that the exact path traveled by the fish between its tagging and recapture points could not be assessed with any confidence. If a fish was tagged off of North Carolina and recaptured in the Azores, did it ride the currents of the great North Atlantic gyre or did it navigate the vast Sargasso Sea to reach its destination? Mather's tags couldn't answer this question, and there was much more he wanted to know. A new technology was needed that could not only fill in the gaps about migratory patterns but also complement the pioneering tagging efforts of Mather.

Enter Frank Carey, also of Woods Hole Oceanographic Institute, who would be the first to use acoustical tags on large pelagics, such as sharks and swordfish. He was able to track the fish continuously by following a "pinger" attached to fish. The acoustic tag sends data in the form of sound pulses from the fish to a receiver on a ship. This tag had a limited signal range, requiring the tracker to remain in relatively close contact with the fish.

Buoyed by his initial success, but realizing the limitations of these first acoustic tags, Carey was ready to take the next big step in fish tracking. In 1992 and 1993, Carey successfully attached satellite tags to the dorsal fins of blue sharks in New England waters. Why sharks, which by their very nature can be unpredictable? Carey knew that these creatures occasionally cruise the surface with their dorsal fin above the water, and

thus during this relatively brief period, the tag has a "window" to transmit its data to an orbiting satellite.

In 1994, Barbara Block, a protégé of Carey, attached a new towed satellite tag to a blue marlin during the Hawaiian International Billfish Tournament in Kona. Her previous work had determined that marlin, like blue sharks, spend time near the surface, and the uploading of data from marlin to satellite was indeed feasible. While Block was able to obtain a couple of satellite uplinks from the marlin, the amount of data retrieved was limited.

Undaunted, Block pressed on, energized by the fact that the rapid pace in the miniaturization of computer chips, which was occurring in the mid-1990s, fostered the development of microprocessors that could store large amounts of data in a small package. Block, as she recounted in her 2005 survey article on advancements in fish tracking, began a fruitful collaboration with Roger Hill, a pioneer in wildlife telemetry, in 1994. The result of this teamwork was the development of a new tag, which would record depth, light, ambient temperature, and the fish's internal temperature at two-minute intervals and archive all the data. Whereas the tags that Hill used in tracking marine mammals weighed several pounds, these prototypes weighed just over an ounce. As reported by Rick Gaffney in *Sport Fishing* magazine, Block and her coresearchers proved they could haul a live bluefin tuna from the waters off of North Carolina onto the deck of a boat, implant an archival tag into its gut, and release it alive. This was the beginning of the successful Tag-A-Giant (TAG) program, which yielded detailed data about the vertical and horizontal movements and habitat preferences of tuna. The downside, as with the conventional dart tag, was that the animal had to be recaptured to access the data, since the tag is sewn inside the fish. Over the experimental period, only eight fish were recaptured by Atlantic fishermen, representing only 5 percent of the tags from the TAG program.

Realizing the shortcomings of her towed-tag experiment in Kona but also acknowledging the potential of satellite technologies, Block expanded her research interests into developing yet another tag: one that would release ("pop off") from the fish, float to the surface, and immediately start transmitting data to a passing satellite. She enlisted

the support of Paul Howey, an expert on telemetry, who built the guts of the tags. In the meantime, Block's team, which included Heidi Dewar, Charles Farwell, and Eric Prince, worked on developing and testing different flotation attachments for the tag, as well as evaluating various shapes for the float to maximize its streamlining. In February and March 1997, within the context of the TAG program, thirty-seven tuna were the recipients of the first pop-off tags, which to the delight of all worked almost flawlessly—95 percent of the tags released from the fish.

What has been the end product of all this development and testing? It is the pop-up satellite archival tag (PSAT), which blends the best of the basic archival tag and the pop-off satellite tag. And over the past few years, the PSAT technology has grown rapidly, leading to several models that vary in the type of data collected; in the programmed release time; in the data stored; and in the data transmitted. Today's PSATs are programmed to initiate data transmission to the satellite under three different scenarios:

1. the PSAT remains attached to the fish until its programmed release date, at which time it releases, floats to the surface, and begins the data uplink;
2. the tagged fish dies, and upon sinking to a depth between 3,700 and 5,550 feet, the PSAT releases, floating to the surface to begin its transmission;
3. the tag experiences minimal pressure changes for a predetermined number of days, usually two to four, and the PSAT jettisons from the fish.

Though PSATs have proved to be valuable research instruments—unlocking some of the secrets of large pelagic wanderers—they have, at times, frustrated their users: yielding lower-than-expected reporting rates, providing incomplete data, and detaching earlier than programmed. The latter problem has been a particularly prickly one since the vast majority of PSATs, upwards of 80 percent, are released before their preprogrammed pop-up date. Also throw in the cost of the tag—$3,000 to $4,000 each, plus $500 satellite time for each tag—and some have argued about the overall efficacy of the program. For the price of one PSAT, you could purchase 1,300 conventional tags from the Billfish Foundation.

PHOTO 19. Tagging sailfish. Courtesy of NOAA.

And yet the PSATs have had their moments in the sun, winning over converts. One believer is Rob Kramer, president of the International Game Fish Association (IGFA). During the inaugural IGFA Great Marlin Race, six satellite tags were attached to billfish during a tournament (September 5–11, 2011) in Puerto Rico. On January 5, 2012, exactly 120 days after it was deployed, one of the tags released and started transmitting data. Analysis of the data showed that the marlin had traveled an astonishing 4,776 nautical miles, headed in a general southeast direction, crossing the Equator, and released its tag off the coast of Angola, Africa. The total trek may very well represent the longest one ever by an electronically tagged marlin.

Since our picture of billfish migration and habitat is still fuzzy, fisheries biologists will continue to employ the low-end and high-end tags—the low cost and long-term versus the high cost and short-term—to sharpen the image.

Protection for Billfish

Society functions in part because of the existence of boundaries—from property-line demarcations to state lines to international borders. They serve as means of identifying ownership and convey with them certain legal rights that can be upheld in courts of law.

Humanity has long made claims on the sea. By the fifteenth and sixteenth centuries, the doors to the sea began to shut as the maritime superpowers of Portugal and Spain began making preposterous claims to vast areas of the Atlantic Ocean. Emboldened by Columbus's voyage of discovery, Spain petitioned Pope Alexander VI (a Spaniard) to issue a papal decree that ostensibly awarded almost all of the New World to Spain. At its core, the decree forbade any nation to cross, regardless of the reason, a line drawn at 35° west longitude. Spain would have domain over the waters of the western Atlantic and the Gulf of Mexico. Coupled with Portugal's claim to exclusive rights to the rest of the Atlantic, this order ushered in the dark period of closed seas, or *mare clausum*. While these claims were mainly for the riches found on land, this mindset of assigning control would in the future extend to the biological resources of the seas. Stemming from our own hubris, we would

apply our terrestrially centered ideas about boundaries to the oceans' creatures.

Since humans have generally been ignorant of the natural linkages that exist across oceanic ecosystems, they have arbitrarily divided the oceans' waters for management purposes. Centuries ago, coastal nations agreed in principle that their individual maritime claims extend a fixed distance seaward from land. A workable formula was developed in 1702 by Cornelius Bynkershoek, a Dutch jurist and legal theorist, restricting dominion to the actual distance of a cannon shot—thus was born the three-mile limit. Since the mid-twentieth century, numerous nations came to view the three-mile limit as an archaic concept of the international law of the seas and were eager to extend their claims well beyond this traditional boundary. By 1982, the United Nations Convention on the Law of the Sea (UNCLOS) had defined territorial seas—a zone of coastal waters extending twelve nautical miles from the mean low-water mark of a coastal state, over which the state has sovereign rights. In addition, the Law of the Sea treaty guaranteed the Exclusive Economic Zone (EEZ), which extends offshore for two hundred nautical miles, and in which a coastal nation has control of all economic resources, including fisheries. While such zones are deemed adequate to assign jurisdiction, they do little to promote the effective management and governance of pelagic species, particularly those that migrate long distances, from an international perspective.

The term "highly migratory species" was first addressed, at least legally, in Article 64 of UNCLOS. While the participants to the convention did not arrive at an operational definition of the term, they did arrive at a consensus of those species considered highly migratory. Billfish, due to their recognized wide geographic distribution, were included in this group.

In the early studies of migratory or sedentary marine species, biologists generally took a reductionist approach—understand the basic components then extrapolate to a comprehension of the whole. The roots of reductionism date back to the ancient Greeks, in particular to Democritus, who taught that to understand something fully, one should begin by dissecting it into smaller parts. By the seventeenth century, René Descartes, a French philosopher and mathematician, would

be instrumental in spreading the gospel of reductionism, which is now recognized as a maxim of the scientific study of nature.

This approach found its way into fisheries science through the concept of fish stock. In 1968, biologist D. H. Cushing said, "A stock may be defined as a population in which the vital parameters of recruitment, growth, and mortality are homogenous." In other words, a stock is a discrete group of fish, which have a degree of reproductive isolation from other groupings of the same species. The population dynamics of each group is controlled mainly by interactions of individuals within each distinct group, not external factors. But setting boundaries and identifying stocks are, in effect, determining which subpopulation of a particular species of fish is going to be managed. Thus Gavin Begg, Keith Friedland, and John Pearce have taken a broader approach in their definition of a stock: it "describes characteristics of semi-discrete groups of fish with some definable attributes which are of interest to fishery managers." But Begg and John Waldman would further argue that "regardless of its precise definition and biological underpinnings, the stock concept really has to do with the interaction between a fish species and its management."

But how do we manage fish stocks that cross arbitrary, political boundaries? Though not directly using the term "straddling stock" in its deliberations, UNCLOS refers instead to a "stock or stocks of associated species occurring both within the exclusive economic zone and in an area beyond and adjacent to the zone." The Food and Agriculture Organization of the United Nations is more specific in its definition: "Fish stocks that migrate between the EEZs and the high seas," adding the concept of species mobility during a life cycle. The term "high seas," as adopted by the 1958 Convention on the High Seas, "means all parts of the sea that are not included in the territorial seas or in the internal waters of the State." The convention also codified the rules of international law relating to the high seas, which included freedom of fishing. And therein lies the root of the fisheries management problem: if the high seas are open to all nations, and no state may exert its sovereignty over this area, then its resources are open to the unlimited exploitation by any nation. A situation not foreseen by UNCLOS and others was that of a stock occurring within the EEZs of two or more

coastal states and the adjacent high seas—the highly migratory stock, which is now recognized by fisheries biologists through their myriad tracking endeavors to include billfish.

The international management of highly migratory stocks falls under the auspices of the International Commission for the Conservation of Atlantic Tunas (ICCAT), a governing body of fifty member nations. But the organization has been widely criticized by environmental organizations and U.S. officials for failing to govern in the best interests of the species it is charged to manage—advocating short-term policies that favor commercial fishermen over developing and implementing long-term conservation measures. According to *Webster's New College Dictionary*, to "govern" is "to set forth and administer the public policy and affairs; to exercise sovereign authority." From a resources perspective, this rather sterile definition is sorely lacking, for nowhere does it suggest or imply that the rulers should govern wisely, becoming stewards of the resources they are charged to manage. While ICCAT was ostensibly developing and setting policy over the years, the billfish population was in freefall, with white marlin declining by as much as 90 percent and blue marlin decreasing by 65 percent. As a result of these historic declines, the International Union for the Conservation of Nature (IUCN) announced in 2011 that white and blue marlin have been added to its Red List of threatened species—a worldwide, peer-reviewed standard for assessing the status of species. The reduction of these apex predators can have a ripple effect throughout the entire pelagic food web, negatively impacting even the lowest food levels—a fear harbored by many fisheries biologists and managers.

The high billfish mortality, 80 percent of the total landings, is mainly the result of bycatch in various commercial fisheries, particularly pelagic longline fisheries for tuna and swordfish. Since many of these longlining operations are by foreign nations and take place in the high seas, regulation, from a political perspective, has been exceedingly difficult. In contrast, since 1988, the U.S. Atlantic longline fishery has been prohibited from retaining any billfish; dead or alive, all billfish must be released. ICCAT has historically turned a blind eye to these extremely exploitative fishing practices by foreign nations, routinely ignoring the advice of its own scientific advisors. Its actions to date have

been to view the loss of billfish, which it has relegated to role of bycatch species, as simply the cost of doing business.

ICCAT's actions and philosophy stand in sharp contrast to those of the United States. During the late 1980s, American fishery officials realized that the domestic management of billfish was in need of revision. Previously, all species found in the EEZ were managed by Fishery Management Councils, which implemented regulations for species in their geographic area, such as the mid-Atlantic states. While suitable for species that exhibit very little mobility, different management plans by different councils (there are five councils from the Caribbean to the Gulf of Mexico to the eastern seaboard) were deemed unworkable for highly migratory species. During his time in office, President George H. W. Bush signed into law the Fishery Conservation Amendments of 1990, which, among others things, transferred management of these species from the councils to one overseeing agency—the Highly Migratory Species Management Division.

The dogged efforts of the U.S. delegation at ICCAT meetings may be turning the tide, albeit slowly, in the favor of billfish conservation. One measure adopted by ICCAT members in 2000 requires the release of all live marlin from longline vessels. A 1998 study showed that almost 50 percent of the blue marlin caught in the Venezuelan longline fishery are alive at the time of haulback. All good and well, but if the marlin are released, how many survive? To answer that question, David Kerstetter in collaboration with Brian Luckhurst, Eric Prince, and John Graves tagged (PSATs) a total of nine blue marlin caught by longline vessels in Bermuda and Florida waters. The researchers recorded that seven of the nine deployed PSATs reported data as programmed, assuming the two nonreporting tags were mortalities, yielding a postrelease survival rate of almost 80 percent. While the sample size was small, and the sampling was confined to the western Atlantic, the results demonstrated that management measures requiring live releases have the potential of reducing marlin mortality.

At the 2010 ICCAT meeting in Paris, France, Ellen Peel, president of the Billfish Foundation, noted, as reported by Pete Johnson of Johnson Communications, that "these conservation measures have resulted in the first positive increase in white marlin stocks in over three decades."

For Peel, who served as the U.S. Recreational Fishing Commissioner during the meeting, the uptrend, albeit not enough to remove the white marlin from the threatened list, was a small victory for the recreational angling community, which generates billions of dollars to the U.S. economy. Peel also strongly argued that "sportfishing for billfish, which is primarily catch and release, is compatible with conservation and strong economic returns to nations at a time when more and more stocks of fish are overfished and overfishing is occurring with some."

The battle for healthy billfish stocks continues on many fronts. More than two decades ago, the United States, recognizing the signs of an overfished species, banned the commercial harvest and sale of Atlantic-caught billfish. But a nagging loophole persisted: with the exception of striped marlin caught off the West Coast, there was no similar ban on the sale of Pacific-caught billfish. Thus ironically, the United States became the largest importer of billfish in the world, with imports at approximately 1,340 tons annually or according to the Food and Drug Administration about 30,000 billfish. The IGFA and the National Coalition for Marine Conservation (NCMC) have identified Costa Rica, Ecuador, Vietnam, South Korea, and the Philippines as the top exporters of billfish to U.S. markets and have spearheaded the program Take Marlin off the Menu.

Advocates of this campaign to remove marlin from restaurants and seafood vendors have come to realize that their greatest challenge is drawing awareness to the plight of marlin and other billfish. As shown by a national Harris Interactive consumer survey in 2009, the public is painfully unaware of the unsustainable decrease in billfish stocks, with 93 percent of survey responders expressing complete surprise that the billfish numbers have plunged 80 percent from their peak several decades ago. This disturbing finding can be traced back in part to how humans have traditionally viewed the ocean—a dark, alien environment whose creatures remain both elusive and reclusive. On land, observations of life can be made relatively easily and with significantly less effort compared to that of the vast seas. Apex terrestrial predators, such as lions and tigers, are accessible, leading to intensive study and copious documentation of these organisms. To rectify common misconceptions about the sea, education and outreach efforts by

the IGFA, NCMC, and the Billfish Foundation are yielding dividends. According to Ken Hinman, president of the NCMC, "American consumers are sending America's chefs, restaurant owners and seafood retailers a clear message—Take Marlin off the Menu." And some are listening. Renowned international chef Wolfgang Puck, a man associated with revolutionizing fine dining in America and around the world, has firmly embraced the concept of sustainability by refusing to serve marlin at any of his restaurants.

Currently, the National Marine Fisheries Service manages the blue marlin as two distinct stocks—the Atlantic and Indo-Pacific stocks. But for years, blue marlin caught in the Atlantic were illegally marketed as originating from the Indo-Pacific stock, for which there are currently no restrictions with regard to its sale. Many of these magnificent fish are sold in restaurants and in Caribbean stands as fish-on-a-stick and as filling for fish fritters. According to Jeff Radonski, who is in charge of NOAA's Office of Law Enforcement Southeast Division, when he spoke with David Malmquist, communications director at the Virginia Institute of Marine Science (VIMS), "Domestically, commercial fishing operations generally aren't a problem. But a black market does exist that may be supplied with recreationally harvested billfish. In some places, recreational anglers opportunistically target Atlantic marlin and sailfish for sale as a means of covering their expenses. The potential issue is locally harvested marlin being comingled with legally imported marlin through fraudulent Certificates of Eligibility or invoices."

Enter the VIMS "marlin forensics" team—graduate student Laurie Sorenson, molecular biologist Jan McDowell, and professor John Graves—which has developed a genetic test that will allow seafood agents to determine quickly and accurately a blue marlin's ocean of origin. The test uses specific genetic markers—repeating sequences of genetic material along the strands of DNA—to discriminate between Atlantic and Indo-Pacific blue marlin. Individuals from a particular stock, such as the Atlantic, will all exhibit a similar pattern that will be distinctively different from that of another stock. As told to Malmquist, Sorenson related that "use of these markers will provide a more powerful means of identifying oceans of origin, allowing enforcement of regulations for these species." Sorenson hopes that the new test puts an end to the black market for Atlantic-caught billfish.

TABLE 1. Timeline of Events Pertinent to Billfish Evolution, Fishing, and Conservation

Time	*Event*
410–359 million years ago	Devonian Period: Age of Fishes
359 million years ago	Devonian extinction
230 million years ago	Earliest teleosts
200 million years ago	Breakup of Pangaea
55 million years ago	Ancestral billfish
30 million years ago	Existence of Gulf Stream
15 million years ago	Appearance of blue marlin, sailfish, and swordfish
5 million years ago	Appearance of white marlin and spearfish
5,000–3,000 B.C.	Subsistence swordfishing in the Gulf of Maine
ca. 850 B.C.	Swordfish in Greek mythology
ca. 350 B.C.	Aristotle's research on swordfish
ca. 50 B.C.	Pliny the Elder details habits of swordfish
1850–1900	New England swordfish harpooners
1898	Avalon Tuna Club
1913	First swordfish caught on rod and reel by William Boschen
1916	Zane Grey catches sailfish in the Florida Keys
1930s	Hemingway pursues marlin in Cuban and Bahamian waters
1939	Formation of the International Game Fish Association
1952	Publication of Hemingway's *The Old Man and the Sea*
1954	Establishment of the Cooperative Game Fishing Tagging Program
1958	First documented case of catch and release of a blue marlin
1962	First billfish (sailfish) caught on a fly by "Doc" Robinson
1976	Magnuson Fishery Conservation and Management Act
1982	United Nations Convention on Law of the Sea
1986	Establishment of the Billfish Foundation
1998	"Give Swordfish a Break" Program
2012	Billfish Conservation Act signed into law by President Barack Obama

The billfish conservation push appears to be gaining steam even in the often contentious U.S. political arena. On August 29, 2011, Senator David Vitter (R-LA) and Congressman Jeff Miller (R-FL) teamed up with eleven other members of Congress to introduce the Billfish Conservation Act of 2011—bipartisan legislation that will help to restore the severely depleted billfish populations. At its core, the legislation explicitly prevents the sale of all billfish except swordfish in the United States, to send a clear message that the future of billfish is not up to the highest bidder. Including a ban on Pacific imports, the legislators also hope to strengthen the U.S. resolve to push for international cooperation and measures to protect billfish throughout the Indo-Pacific sphere. Support for this act was immediately widespread, as numerous environmental and conservation organizations, including the American Sportfishing Association, the Center for Coastal Conservation, the Guy Harvey Ocean Foundation, and the IGFA, championed the bill. The culmination of this united front was the signing of the Billfish Conservation Act into law by President Barack Obama on October 5, 2012.

American scientists, fisheries managers, and conservation organizations realized that it would be hypocritical on their part to advocate for worldwide billfish conservation measures without being cognizant of what's going on in their own backyard, particularly with regard to commercial fishing operations within the EEZ. Though only 5 percent of the total reported Atlantic billfish catch is from dead discards of the U.S. pelagic longline fleet, which targets swordfish and tuna, that amount was viewed in many quarters as not being insignificant and in need of reduction. The legal impetus for improvements in domestic management of billfish started in 1996 when Congress amended the Magnuson Fishery Conservation and Management Act of 1976 (the primary domestic legislation for regulating fisheries within the EEZ), with a new emphasis on the precautionary approach in fishery management policy. One of the new provisions required managers to minimize bycatch and bycatch mortality, to the extent practicable.

While some progress has been made in modifying longline gear to minimize its impact on seabirds and turtles, the only practical method to decrease the bycatch of protected or prohibited fish is to remove the gear from the water, where and when it is having the most negative

PHOTO 20. Marlin caught off of Catalina Island, early twentieth century.
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influence. Under pressure from the NCMC, which in 1999 initiated a lawsuit over swordfish, billfish, and shark bycatch, the National Marine Fisheries Service (NMFS) closed 133,000 square miles of waters off the southeast U.S. coast. These closures, which went into effect in March 2001, included some prime spawning areas in the Gulf of Mexico and billfish migration routes along the eastern seaboard. Once the closures went into effect, fishing efforts were reduced, but would they achieve the desired result of significantly reducing billfish bycatch? In 2007, the NMFS had the answer—a 67 percent decrease in bycatch as compared to the preclosure period. While the decrease in bycatch proved the value of discrete area-time closures, the NCMC cautioned against overoptimism, expressing concerns that underreporting of bycatch—captains are required to maintain accurate logbooks showing all billfish landed—could skewer future results. Also, future shifts in longline effort may negate closure effectiveness. In spite of these potential drawbacks, the NCMC continues to take a proactive position with regard to closures, arguing that the Atlantic-wide recovery of billfish is only possible with ICCAT seriously evaluating the implementation of area-time closures on the high seas, which in conjunction with catch restrictions, live-release of billfish, and the use of circle hooks will achieve the goal of full recovery. A holistic approach, not piecemeal, to managing billfish should be adopted by all parties to ensure the survival of these majestic creatures for future generations.

A Changing Earth: Impacts on Billfish

Billfish, as are almost all terrestrial and marine species, are parts of an ecosystem, where there is interaction among the various components, and where the removal or failure of even one part can spell disaster for the whole. Ecosystems, like the inner components of a computer, are not amenable to a high degree of meddling. Robust, healthy ecosystems need to reach and maintain a level of stability. While there may be perturbations, both internally and externally, which incrementally affect the stability, ecosystems through a system of feedbacks gravitate back to an equilibrium state.

The science, some will call it an art, of estimating the number of fish in a particular stock or population has never been easy, fraught with

many uncertainties and often couched in esoteric statistics. Some of the stumbling blocks with regard to obtaining accurate stock assessments of Atlantic billfish include:

1. Billfish roam vast expanses of the Atlantic Ocean and are relatively rare compared to other species, making them difficult to study in sufficient numbers to draw conclusions about their population size.
2. Many countries that catch billfish do not routinely report their landings to the appropriate resource managers.
3. Stock assessment models are not robust or sophisticated enough to capture and take into consideration all the nuances of a billfishing operation, such as type of gear and the impact of bycatch.

But accurate counts are critical not only in assessing the overall vitality of the population but also for formulating and implementing management strategies.

Arriving at a population census is further complicated by climate change, which influences the numbers and distributions of fish populations directly through abiotic (for example, temperature, salinity) factors and indirectly through the availability of food and the presence or absence of competitors and predators. Climate change occurs at different time scales, ranging from a few years to decades to millenniums.

One particular climatic phenomenon that has been studied extensively is the El Niño—a wind-driven reversal of the Pacific equatorial currents, occurring every three to seven years, resulting in the movement of warm water toward the coasts of the Americas and a deepening of the oceanic thermocline. The occurrence of an El Niño has a marked influence on the density and distribution of blue marlin, which have a preference for particular habitat-related factors, such as the warm surface waters above the thermocline. Specifically, during these events, the marlin extended their geographical range and vertical movement, moving eastward toward the Americas and swimming at deeper depths. During the 1997 El Niño event, for example, blue marlin were observed off California and as far north as the Washington coast. Their near-shore movement was particularly surprising since these fish are blue water, pelagic species, generally found a considerable distance from land. In response to this climatic event, the blue marlin had undergone a distinct regime change, albeit for a relatively

limited period, until the El Niño weakened and oceanic conditions returned to their normal state.

And yet there are times when stability can be irreversibly damaged, as the geologic record shows. Over the last 500 million years, five distinct extinction events occurred, which though markedly reshaping life on earth were spaced out over tens of millions of years, allowing a certain degree of stability to return, albeit with new players.

What lessons can we draw from a critical study of the past? The relevance of the past to the present is that cataclysmic spasms are an integral part of the earth's history and most likely will occur again. There is concern within some quarters of the scientific community that we are already in a period of environmental upheaval, occurring at a rate unprecedented in the geologic record. As opposed to during the five previous catastrophic events, the biosphere is now subject to massive forces initiated and enhanced by human activities. To some, the loss of species may be of little concern, since every day species vanish from the earth with relatively little fanfare or any noticeable impact. But the earth may be reaching a tipping point when the loss accelerates at such a pace to affect entire ecosystems, eventually leading to their collapse. Stability is replaced with runaway instability.

For years, there have been debates, many quite contentious, within the scientific and political arenas about the impact of the increasing concentration of carbon dioxide in the earth's atmosphere, which since the start of industrialization has increased at a rate of 2.2 percent per year. The present concentration, 392 parts per million, stands as the high-water mark over the last five hundred thousand years. While most sources of carbon dioxide emissions are natural, the increasing trend in atmospheric carbon dioxide appears to be the result of anthropogenic activities (burning of fossil fuels and deforestation as the main culprits).

Carbon dioxide is a major greenhouse gas, trapping and absorbing infrared radiation that is emitted from the earth's surface. This insulating effect is said to result in an increase in temperature, and both direct and indirect evidence does indeed point to a warming planet.

But what would be the consequences of an environment in flux for billfish? The jury is still out with regard to arriving at a definitive verdict,

but modeling and simulation efforts are at the forefront in assessing the temperature tolerance of different species. In particular, one study of eighteen pelagic fish showed that while bluefin tuna, bigeye tuna, and swordfish have the largest ranges of mean temperature tolerance, marlin and sailfish were skewed toward the warmer end of their mean tolerance range—a result not truly surprising. In a warming seas scenario, as with El Niño events, one possibility is the redistribution of billfish concentrations or a change in preferred habitat.

Other research efforts on the effects of a potentially overheating planet have taken a smaller view, concentrating on the microscopic phytoplankton. One recent study by Daniel Boyce and his colleagues, published in the scientific journal *Nature*, shows that phytoplankton are in grave danger. The global population of these organisms has dropped about 40 percent since 1950. The researchers at Canada's Dalhousie University, using a stream of multidata sets, observed declines in phytoplankton amounts in eight out of ten oceanic regions and were able to relate these long-term declining trends to increasing sea surface temperatures. They argued that the warmer water inhibits nutrient influx to the surface waters by increasing the thermal stratification between top and bottom. While this finding has generated some controversy in the scientific community, it is disturbing to ponder the potential implications, including massive disruptions in food availability. The loss of these foundational organisms would have a negative rippling effect throughout the entire food chain.

Dissolved oxygen, which billfish need in large amounts, is decreasing in parts of the world's oceans, causing alarm among fishery biologists, who fear a shrinking of billfish habitat. Oxygen-minimum zones are naturally occurring hypoxic layers found at depths between six hundred and three thousand feet and generally are the lower boundaries for blue marlin and sailfish movement. Due to a combination of meteorological, oceanographic, and biological processes, these oxygen-poor waters cover large swaths of the eastern tropical oceans. And these hypoxic waters have expanded both horizontally and vertically, further decreasing the Atlantic blue marlin habitat by 15 percent.

To test the response of billfish to different oxygenated environments, Eric Prince, lead investigator, and his crew deployed PSATs on thirty-two

sailfish and forty-seven blue marlin. A meticulous analysis of the data showed that both species ventured deeper where dissolved oxygen levels are relatively high, as in the western Atlantic, but they spent a greater portion of their time in near-surface waters of the eastern Atlantic, where the low dissolved oxygen amount squeezed the fish closer to the surface. Prince is duly concerned that these habitat-restricted billfish are swimming between the devil and the deep blue sea: the high seas commercial fishing operations and the relentless encroaching mass of suffocating water. He warns, "The shrinking of habitat due to expanding hypoxic zones needs to be taken into account in scientific stock assessment and management decisions for pelagic billfish and tuna."

The outlook for billfish under a changing climate scenario may not get any rosier. Climate models predict a continued expansion of the oxygen minimum zones and an overall decrease in dissolved oxygen concentrations as the planet continues to overheat. In particular, upper-ocean warming will lead to less dissolved oxygen since this warm water will hold considerably less oxygen than cold water. Like an open soda bottle that loses its fizz over time, the warm ocean will release oxygen back into the overlying atmosphere, going flat with regard to life-giving oxygen. In the viselike grip of a warming environment, even the mobile billfish may have difficulty finding suitable habitat.

The ocean layers due to their density differences tend toward a stable state, one that is characterized by the lack of overturning, which thus isolates the deeper waters from the oxygen-enriched atmosphere. The only possible recharge of oxygen to the hypoxic zone comes from deep-flowing currents, which must make a long-distance delivery.

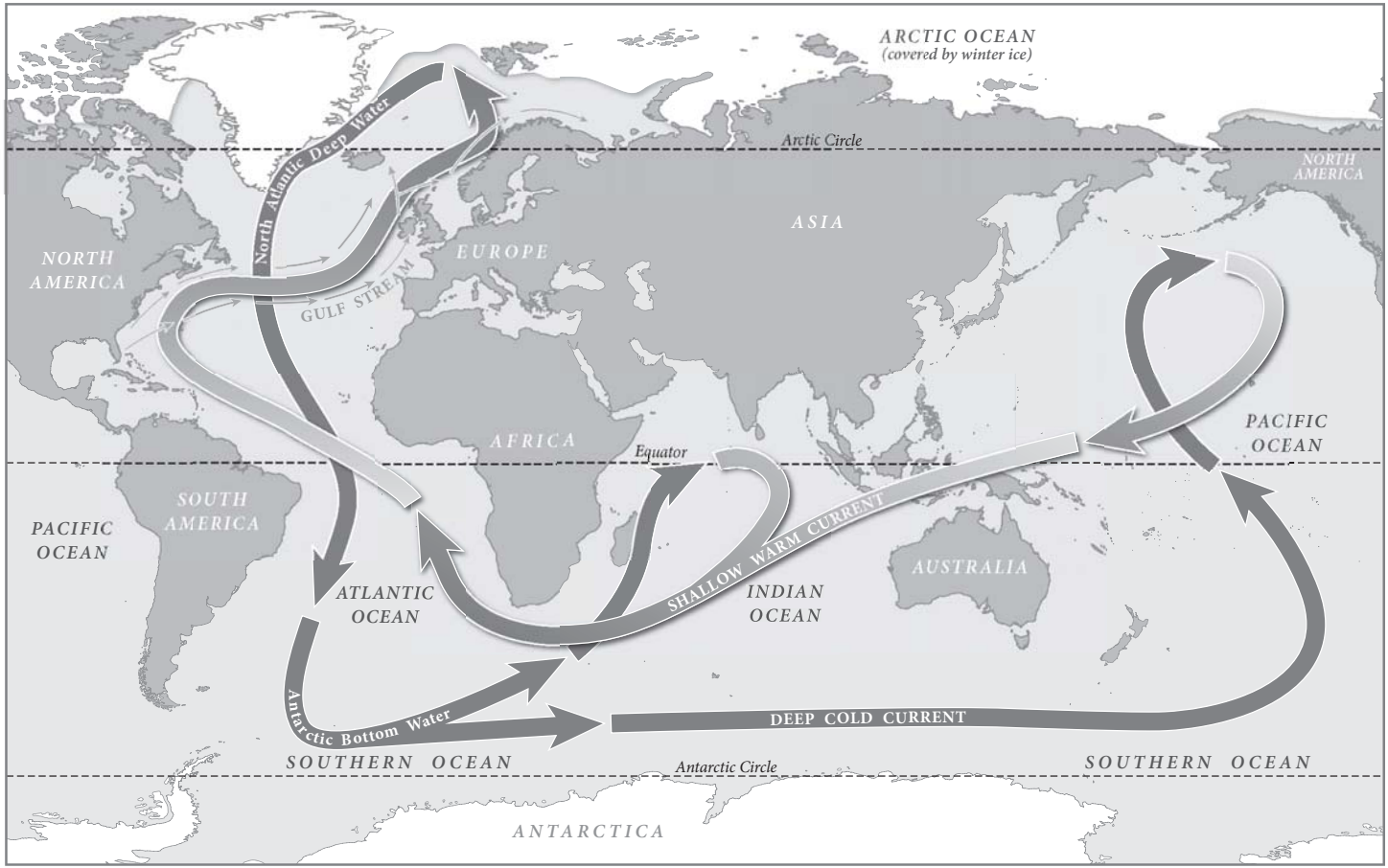
While surface currents, like the Gulf Stream, were being probed and mapped in the eighteenth century by no less a famous figure than Benjamin Franklin, abyssal circulation would remain a mystery for centuries to come. In the mid-1950s, a Woods Hole oceanographer, Henry Stommel, began thinking seriously about deep-water flow. One major consequence of his inquiries into the working of deep circulation was the theoretical prediction of a deep, equatorward current along the North American coast, transporting dense, oxygen-enriched water from the poles to lower latitudes.

In 1957, Valentine Worthington and John Swallow experimentally verified Stommel's prediction by tracking metal tubular floats (Swallow

floats—named after their developer), which could be constructed to float at a predetermined depth. Deploying Swallow floats near Cape Hatteras, they found the instruments sluggishly traveled to the south at a speed of about a third of a knot—contradicting the commonly held belief at the time of a stagnant abyss.

Wallace Broecker, a Columbia University geologist, would expand on the work of Stommel, Worthington, and Swallow by developing a three-dimensional view of global ocean circulation. In a 1987 article in *Natural History* magazine, Broecker proposed a conceptual model linking the horizontal and vertical components of ocean flow; he dubbed it the "ocean conveyor belt." An integral part of Broecker's view of ocean flow is the Gulf Stream. As this current surges northward, its density increases primarily due to cooling and an influx of high-saline water. This dense water sinks and flows southward as the lower limb of the conveyor. (The same flow that Stommel proposed, and that measured by Worthington and Swallow.) The deep current passes under the Gulf Stream and continues southward into the South Atlantic. At the southern tip of Africa, it joins with other abyssal water and continues its journey eastward into the Indian and Pacific Ocean basins. In the Indian Ocean, the deep-water limb rises to the surface and becomes part of the Indian Ocean's Agulhas Current, which flows south along Africa's east coast. Rounding the Cape of Good Hope, this upper limb merges with the Benguela Current, which transports water northward through the South Atlantic. There it is picked up by equatorial currents to complete the cycle back to the Gulf Stream—a journey of more than a thousand years.

But little did Broecker imagine that a disruption in one component could set off a chain reaction that could affect not only billfish but also possibly most of life on earth. Under the scenario of a warming planet, the sinking of Gulf Stream waters ceases at higher latitudes. This link between the upper limb and the lower limb of the conveyor belt is severed, causing a shutdown in the whole ocean conveyor belt, a decrease in latitudinal heat transfer, and setting the stage for onset of a new ice age. The stuff of science fiction? Possibly. But we might want to bear in mind the words of Jules Verne, writing in *Twenty Thousand Leagues under the Sea*: "We then went with the current of the sea's greatest river, which has its own banks, fish, and temperature. I mean the Gulf Stream



MAP 3. Global Ocean Conveyor Belt

. . . we must pray that this steadiness continues because . . . if its speed and direction were to change the climates of Europe would undergo disturbance whose consequences are incalculable."

There are rumblings within the scientific and conservation communities that, under the scenario of a changing climate, protection must be afforded to those species most in danger of possible demise. Polar bears, in particular, have recently garnered a lot of press and attention due to concern about the unprecedented decrease in Arctic sea ice—a vital habitat for these creatures. Calls for increased captivity of polar bears, particularly abandoned cubs, in zoological parks have become strident.

Could aquariums become the refuges of threatened billfish? During the 1990s, a team from the University of Miami undertook the delicate task of collecting and keeping alive billfish larvae in a laboratory setting. Their efforts were rewarded; for the first time in history, the researchers were able to study the eighth-of-an inch larvae up close in captivity. But their success was tempered by the fact that the captive fish lived for only three days in spite of the Herculean effort to replicate as close as possible their natural environment, albeit on a scaled-down version. Even with the passing of time since this pilot project, researchers have been unable to grow and rear billfish successfully in captivity. Raising billfish, like trout, in a hatchery setting or sequestering them for long periods of time in an aquarium may not be viable options for solving the plight of climate-stressed billfish.

While I may have painted a rather disturbing and distressing picture of the fate of billfish, I am optimistic about their survival; at least, I want to be. Granted I have no grand solutions—I'm not sure anyone does—to the problems that beset billfish. Lacking any "silver bullet," I believe in the resiliency of these grand fish, which for millions of years have roamed the tropical and subtropical seas, adapting to whatever nature has offered up. I hope that they have many jumps left in them.

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